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THE GREAT CAÑONS OF THE COLORADO RIVER.

BY GEORGE E. ROBERTS.

(With a Coloured Plate.)

THE nautical enterprise undertaken in 1857-8 by Lieutenant St. Ives, at the command of the American Government, to ascertain the navigability of the Colorado River of the West has been productive of high scientific results, as well as successful in its more immediate object of opening an economical avenue for the transportation of supplies to military posts in New Mexico and Utah. The memoir of the expedition, published by the War Department of the United States in 1861, has not received the attention in this country which its merit deserves, and which it fairly claims from all geographers and geologists. The enormous difficulties which beset the course of the explorers after the navigable, or lower portion of the Colorado River had been passed, render it extremely unlikely that any second party will ever penetrate into the inhospitable, but marvellously beautiful country, which headed off all their attempts at progression. "Ours has been the first, and will, doubtless, be the last party of whites to visit it," writes the leader of the exploring band. "Everywhere our reconnoitring parties have been stopped by impassable obstacles. It seems intended by Nature that the Colorado River, along the greater portion of its lonely and majestic way, shall be for ever unvisited and undisturbed." Arid table-lands, channeled in every conceivable direction with the deepest and most dismal abysses existing upon earth; tenantless, both by Indian tribes and by animals and birds, for even those which inhabit the surrounding territories seem to have deserted it, down to the smallest reptile; without water—"a more frightfully arid region probably does not exist upon the face of the earth;" and, as a natural consequent, almost without vegetation; the territory which shuts in the rise of the Colorado

River has no inviting prospect for the colonist, or charm for any traveller, save an arduous pursuer of the wildest scenery.

The characteristic of its scenery is a series of cañons, or deep precipitous passes, through which the river winds, and these increase in height and sublimity towards the north, until the rise of the river is traced to gorges in the Rocky Mountains, the almost perpendicular walls of which measure over a mile in height. The Colorado River is, with one exception, the largest stream which flows from American territory into the Pacific Ocean. Very little has been known till lately concerning its course and the grandeur of the near-lying scenery; though, singularly enough, some portions of it were among the earliest parts of America explored. In less than fifty years after the landing of Columbus, Spanish missionaries and soldiers were travelling upon it, following its course for a long way from the mouth, and even attaining one of the most distant and inaccessible points of its upper waters, for one Captain Cardinas reported in 1540 that he had arrived, guided by Indians, at a part of the river where "the banks were so high that they seemed to be three or four leagues in the air." This is the first notice of the famous Big Cañon of the Colorado.

The record of the Government exploring party is set out with so many scenic observations that we seem scarcely to need the help of the many views, maps, and charts which illustrate it, to aid our realization of their voyage.

Starting from the mouth of the river in the Gulf of California, a foretaste of glorious scenery to come was given by a powerful mirage, converting the outlines of distant hills into fanciful shapes of castles, domes, and giant statues, painted with glowing purple tints and sharply-defined tracery on the blue background of the sky. Beyond the mouth, glittering islands broke up the monotony of the broad stream, and green lawns, on which myriads of pelicans were congregated, sloped down to the water's edge. A few miles from the mouth the phenomenon of a tidal "bore" was discovered: a single immense wave, which rises to the height of ten or twelve feet, and ascends for many miles up the current; an analogous phenomenon to the well-known one which occurs at high tides near the confluence of the Severn with the Bristol Channel. From the mouth to the pass of the Purple Hills, a distance of 450 miles, the scenery did not call for special remark, but from that point began the wonders of the river. Sailing past a range of chocolate-coloured mountains, and through a gateway formed by a huge crag of vivid red rock, they reached the Monument Mountains, and the first of the great series of cañons which were in future to hem in their course.

"Immediately above the river grew narrower and deeper, and the hills crowded closely upon the water's edge. The regular slopes gradually gave place to rough and confused masses of rock, and the scenery at every instant became wilder and more romantic. New and surprising effects of colouring added to the beauty of the vista. In the foreground, light and delicate tints predominated, and broad surfaces of lilac, pearl-colour, pink, and white, contrasted strongly with the sombre masses piled up behind. In their very midst a single pile of a vivid blood-red rose in isolated prominence. A few miles higher a narrow gateway opened into the heart of the mountains. On one side of the entrance was a dark-red column; on the other a leaning tower of the same colour overhung the pass, the ponderous rocks seeming ready to fall as we passed beneath. Rich hues of blue, green, and purple, relieved here and there by veins of pink and white, were blended in brilliant confusion upon the sides of the cañon, producing a weird-like and unearthly effect, which the fantastic shapes and outlines of the enclosing walls did not diminish. For six miles we followed the windings of the river through this fairy-like pass, where every turn varied and heightened the interest of the pageant, and then the lines of cliffs stopped, and we issued suddenly from the cañon into a comparatively open valley."

Beyond this they came to the still more wonderful cañon through the Mojave Mountains:—

"A low purple gateway and splendid corridor, with massive red walls, formed its entrance. At the head of this avenue, frowning mountains, piled one above the other, seemed to block the way. An abrupt turn at the base of the apparent barrier revealed a cavern-like approach to the profound chasm beyond. A scene of such imposing grandeur as that which now presented itself I have never before witnessed. On either side majestic cliffs, hundreds of feet in height, rose perpendicularly from the water. As the river wound through the narrow enclosure, every turn developed some sublime effect or startling novelty in the view.

"Brilliant tints of purple, green, brown, red, and white illuminated the stupendous surface, and relieved their sombre monotony. Far above, clear and distinct upon the narrow strip of sky, turrets, spires, jagged statue-like peaks, and grotesque pinnacles overlooked the deep abyss."

Beyond this defile was the great valley of the Mojaves.

"Our proximity to it was soon announced by a lofty column of smoke that ascended from the summit of a little peak near the bank, where a watcher had been stationed to warn the inhabitants above of our approach. In a few moments a gap in the side hills revealed a glimpse of an open country,

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with bright foliage and green trees, and a blue range in the distance, and after traversing a short avenue, lined with low bluffs, and terminated by a narrow gateway, we issued from the hills and beheld the broad and noble valley of the Mojaves stretched before us."

One out of several smaller cañons through which they afterwards passed had some charming features of its own :—

"It was only two or three miles in extent, and the sides were of moderate height, but the gorgeous contrast and intensity of colour exhibited on the rocks exceeded in beauty anything that had been witnessed of a similar character. Various and vivid tints of blue, brown, white, purple, and crimson were blended with exquisite shading upon the gateway and inner walls, producing effects so novel and surprising as to make the cañon in some respects the most picturesque and striking of any of these wonderful mountain passes."

But the "Black Cañon" outvied all its predecessors :—

"In a few minutes, having passed what may be called the outworks of the range, we fairly entered its gigantic precincts, and commenced to tread the mazes of a cañon far exceeding in vastness any that had yet been traversed. The walls were perpendicular, and more than double the height of those in the Mojave Mountains, rising in many places sheer from the water for over a thousand feet. The naked rocks presented, in lieu of the brilliant tints which had illuminated the sides of the lower passes, an uniform sombre hue, that added much to the solemn and impressive sublimity of the place. The river was narrow and devious, and each turn disclosed new combinations of colossal and fantastic forms, dimly seen in the dizzy heights overhead, or through the sunless depths of the vista beyond.

"There was no need of keeping a watch with two grim lines of sentinels, a thousand feet high, guarding the camp. Even though we could have been seen from the verge of the cliff above, our position was totally inaccessible. Darkness supervened with surprising suddenness. Pall after pall of shade fell, as it were in clouds, upon the deep recesses about us. The line of light, through the opening above, at last became blurred and indistinct, and, save the dull red glare of the camp fire (for here the expedition had landed for the night), all was enveloped in a murky gloom. Soon the narrow belt again brightened as the rays of the moon reached the summits of the mountains. Gazing far upwards upon the edges of the overhanging walls, we witnessed the gradual illumination. A few isolated turrets and pinnacles first appeared in strong relief upon the blue band of the heavens. As the silvery light descended, and fell upon the opposite crest of the abyss, strange and uncouth

shapes seemed to start out, all sparkling and blinking in the light, and to be peering over at us as we lay watching them from the bottom of the profound chasm. The contrast between the vivid glow above and the black obscurity beneath, formed one of the most striking points in the singular picture. As we proceeded, the cañon continued increasing in size and magnificence. No description can convey an idea of the varied and majestic grandeur of this peerless water-way. Wherever the river makes a turn, the entire panorama changes; and one startling novelty after another appears and disappears. Stately façades, august cathedrals, amphitheatres, rotundos, castellated walls, and rows of time-stained ruins, surmounted by every form of tower, minaret, dome, and spire, have been moulded from the Cyclopean masses of rock that form the mighty defile. The solitude, the stillness, the subdued light, and the vastness of every surrounding object, produce an impression of awe that ultimately becomes almost painful. As hour after hour passed, we began to look anxiously ahead for some sign of an outlet from the range, but the declining day brought only fresh piles of mountains, higher, apparently, than any before seen.

"We had made up our minds to pass another night in the cañon, and were searching for a spot large enough to serve as a resting-place, when we came into a narrow passage, between two mammoth peaks, that seemed to be nodding to each other across the stream, and unexpectedly found, at the upper end, the termination of the Black Cañon. These great towers forming the northern gateway were striped with crimson and yellow bands, the gravel bluffs bordering the river exhibited brilliant alternations of the same hues, and not far to the east, mingled with the grey summits, were two brilliant hills, altogether of a blood colour, that imparted a peculiarly ghastly air to the scene. Not a trace of vegetation could be discovered, but the glaring monotony of the rocks was somewhat relieved by these fanciful variations of colouring."

At this point, progress up the river had to be abandoned; the water above being of a shoal nature, the current swift, and the rapids numerous and full of danger. This was, then, the practical head of the Colorado navigation. So the expedition proceeded on mules and on foot to the higher plateaux of the N. W. Rocky Mountains, where they discovered still grander scenery.

From this part we must give an extract or two :—

"At last the ridge of the swell was attained, and a splendid panorama burst suddenly into view. In the foreground were low table hills, intersected by numberless ravines; beyond these a lofty line of bluffs marked the edge of an immense cañon; a wide gap was directly ahead, and through it we beheld, to the

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extreme limit of vision, vast plateaux towering one above another thousands of feet in the air, the long horizontal bands broken at intervals by wide and profound abysses, extending a hundred miles to the north, till the deep azure blue faded into a light cerulean tint that blended with the dome of the heavens. The famous Big Cañon was before us; and for a long time we paused in wondering delight, surveying the stupendous formation through which the Colorado and its tributaries break their way."

By dint of much exertion, the elevated plateau was reached, the mighty sides of which formed this stupendous cañon. At a spot near the mouths of Diamond and Cataract rivers, two tributaries of the Colorado, a barometrical observation showed that the almost perpendicular walls of rocks which towered above these streams were over a mile in height! The illustration which accompanies this is a careful reduction of Mr. Egglestein's sketch of one point in this vast river wall.

But the "Big Cañon" was only one of many:—

"The extent and magnitude of the system of cañons in every direction is astounding. The plateau is cut into shreds by these gigantic chasms, and resembles a vast ruin. Belts of country, miles in width, have been swept away, leaving only isolated mountains standing in the gap. Fissures so profound that the eye cannot penetrate their depths, are separated by walls whose thickness one can almost span, and slender spires, which seem tottering on their bases, shoot up thousands of feet from the vaults below."

It may readily be supposed that such a region was but thinly peopled:

"The handful of Indians who inhabit these sequestered retreats, where we discovered them, have probably remained in the same condition and of the same number for centuries. The country could not support a large population, and by some provision of nature they have ceased to multiply. Excepting when the melting snows send their annual torrents through the avenues to the Colorado, conveying with them sound and motion, these dismal abysses, and the arid table-lands that enclose them, are left as they have been for ages, in unbroken solitude and silence."

The exploration of the loftiest of these table-lands nearly proved fatal to the whole party:—

"At the end of ten miles of weary travel, a steep ascent brought us to the summit of a table-land that overlooked the country towards the south for a hundred miles. No place could be descried, far or near, that gave a promise of containing water. The wretched and broken-down animals, now forty-eight hours without drinking, and that, too, while making

long marches under a burning sun, were brought to a halt. They had to be tightly hobbled, for, in their frantic desire for water, nothing else could have restrained them from rushing back to the only place where they were certain of finding it. Too thirsty to graze, they stood all night about the camp, filling the air with distressing cries. This morning, the weakened brutes staggered under their packs as though they were drunk, and their dismal moaning portended a speedy solution of their troubles, should water not soon be found. For the third time the sun rose hot and glaring, and as the great globe of fire mounted the heavens, its rays seemed to burn the brain. The condition of things was desperate, should no water be discovered during the day. A single bad cañon or ravine to turn us from the course for any great distance would be, unquestionably, the destruction of the train."

But, just when matters looked the worst, Heaven sent relief, and men and cattle found life in a pool of clear delicious-tasting water. The lessons in physical geology to be derived from the study of this marvellous district, may well be designated by Dr. Newberry, the naturalist of the enterprise, as of the highest importance. Volcanic action, the sword which cuts so many geological knots, is powerless to account for the formation of these deep, clean-cut fissures, and the isolated fragments of ancient surfaces which overlook them. River action, as exemplified in the downward courses of the Colorado and tributaries from the high table-lands, ten or twelve thousand feet on the west side of the Rocky Mountains, at which they rise, has alone cut into and channeled the district with its wonderful series of cañons. In the lapse of ages, the Colorado has cut its way through the higher plateaux, for at least 500 miles of its course, making deep sections through all the sedimentary strata, and in some cases wearing away hundreds of feet of their granitic base. Thus, in the great cañon of the Colorado "we have the most magnificent gorge, as well as the grandest geological section of which we have any knowledge." The upper Carboniferous limestone forms the top of this section, and beneath it, in natural order, are to be seen the whole of the lower series of that system, with Devonian, and upper and lower Silurian rocks, ending with Potsdam sandstone, resting upon granite, a total exposed depth of 5500 feet!

Dr. Newberry can return no other answer to the question, How came these mighty operations of force to pass? than by referring them unhesitatingly to a system of erosion, to a pure and simple result of water-action.

"Probably nowhere in the world has the action of this agent produced results so surprising, both as regards their magnitude and their peculiar character."

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The volcanic rocks were pictures of beauty in arrangement and in colouring.

"Probably nowhere in the world," writes Dr. Newberry, "is there a finer display of rocks of volcanic origin than may be seen about the southern entrance to the Black Cañon. The beetling crags which form its massive portals are composed of dark-brown porphyry of hardest and most resistant character. Just within the cañon, on the west side of the river, this porphyry is mingled with masses of huge, light-brown trachyte; tufa, pure white, or white veined with crimson; and pale blue obsidian (pearlstone); amygdaloids of various kinds, their cavities filled with different zeolites; black and grey basalts, sometimes columnar; scoria, red, orange, green, or black, and of every grade of texture; porphyries in great variety, including some of unequalled beauty; trachytes and tufas of all colours; obsidian in its various forms; all these are abundantly exposed in the immediate vicinity.

"The view from the western slopes of the Black Mountains, which we obtained from the summits bordering the cañon, is scarcely equalled in its savage grandeur by any I have elsewhere seen. A thousand subordinate pinnacles spring from the mountain side, all displaying the ragged outlines which the materials composing them are so prone to assume, while their colours are as striking and varied as their forms. Not a particle of vegetation is visible in the landscape. As the eye of the traveller sweeps over this wilderness of sunburnt summits, which stand so stark and still, glittering in the burning sunlight, and yet so desolate, he shrinks from the unearthly scene with a feeling of depression which must be felt to be imagined."

Many excellent records of exploratory work have been issued by the American Government during the last fifteen years, but the memoir of the Colorado Expedition is the most complete of them all, both in text and illustrative plates, maps and sections.

The certainty that very few English readers will see the original work, and the extraordinary character of the country traversed, will, it is hoped, justify the lengthened extracts that have been made.

THE SUPPLY AND WASTE OF COAL.

BY PROFESSOR D. T. ANSTED, M.A., F.R.S.

Of all subjects connected with geology, there is not one that possesses more varied interest than coal or mineral fuel. Of its origin and history as a mineral we know little, but that little is extraordinary and unfamiliar, constantly exciting inquiry and attention, and left undecided, notwithstanding the most repeated and the closest investigation. The structure of coal is still a puzzle to the microscopist, to the botanist, and to the geologist. Certainly of organic origin, there is still doubt as to whether some varieties were derived from vegetable or animal life. Certainly vegetable, as much at any rate is, no one has been able to say positively what part was tree vegetation, what was leaf, and what woody tissue, while a good deal may have been once peat-bog, or mere accumulation of sea-weed.

And if the origin of coal is so open to discussion, its geological history is no less so. Who can examine a good natural section in a shaft, or even the rock laid bare by a railway cutting in a coal country, without being struck by the marvellously frequent alternation of seams of coal, shales, and sandstones? A hundred distinct coal seams, of thickness varying from a tenth of an inch to a dozen feet, in a thickness of a thousand feet of strata, is the smallest complication presented to us. In a large majority of the seams it will perhaps be found that rootlets of plants extend down from the coal into a bed of clay below. In others, there will be absolutely no connection of any kind between the coal and the underlying or overlying rock, whether sandstone or shale. Not unfrequently, a band, called a *parting*, of black clay, will be found in the middle of a bed or seam of coal. Now and then the roof or overlying bed of a coal seam is made up entirely of clayey material, in the form of leaves, twigs, and branches of trees, while sometimes a similar appearance will be visible in sands where there is no coal whatever. So much for the association and the mode of accumulation; but what shall we say to the mechanical position in which it is found? In England we are so accustomed in all our coal-fields to find the coal-seams broken and crushed—lifted here out of place; dropped there fifty or a hundred fathoms and lost sight of; re-appearing, where least expected, by another fault; dipping at a high angle in one place, and horizontal in another; the dip considerable, but in the opposite direction, in a third—that we are apt to fancy this to be the normal, or, at least, a necessary condition. An English coal-miner hardly believes that a coal-field can be in proper order without it, and some of our well-meaning but somewhat

hasty writers on this subject have regarded the breaking-up of the coal in this way by fault, as a special and providential arrangement, to bring within range portions of a valuable material which would otherwise have been useless, at least to the present generation. It needs but little knowledge of the coal-fields of other parts of the world to show, in the first place, that vast areas of coal may exist in a workable state, and in the most convenient position, without any faults or fractures at all; secondly, that the faulting is anything but an advantage, even in England; and, thirdly, that the temptation to abuse and waste this valuable material—to throw away more than half the natural supply in order to obtain the remainder at a somewhat earlier period, and at a somewhat cheaper price—has been systematically yielded to by the people supposed to be worthy of this miraculous interposition. Certainly a different distribution of the beds, and a somewhat firmer roof, would have been a simpler and more effectual means of securing a permanent supply.

But without entering into this question, which is not one here to be discussed, there can be no doubt that the extreme complication manifest in the coal measures, the multitude of faults, and the numerous thinnings-out of the seams, as well as the impossibility of identifying beds in distant parts of the country, is connected in an important manner with the general geology of England, and the special structure of the country at the time when the vegetable matter was accumulated, but not at all to the nature of coal itself, or to the removal of coal once formed to a convenient distance from the surface.

The coals of different parts of the world agree in essential characters, but differ so considerably in detail, that no practical difficulty is experienced in distinguishing them. To the uninstructed, there are but three or four recognizable varieties, such as stone-coal, or anthracite, burning without flame; caking-coal, burning with long flame, and cementing into a compact mass as it burns; hard-coal, burning to a white or red powdery ash without caking; and cannel-coal, which does not soil the fingers. Few but those interested in the coal trade, or using coal in large quantities for manufacturing purposes, are aware of the extreme difference in value, and the facility of recognizing the kinds from various localities, or from the several seams of the same mining district.

The points of chief importance in a coal-field, speaking solely with reference to economic value, are the following:—1. The quality of the coal. 2. The thickness of the seam. 3. The depth at which the workings must be carried on. 4. The nature of the roof and floor. 5. The state of the measures with regard to water. 6. The degree to which the measures

are affected by faults and the dip of the strata. A brief notice concerning each of these conditions will prepare the reader for a consideration of the inquiries suggested by the title of this article, namely the probable extent of the supply of coal in our own country, and the degree of economy exercised in getting and using the mineral fuel.

1. *The quality of the coal.* This depends to some extent on the uses to which it is to be applied, for although all fair coal is usable for most purposes, and saleable, the value differs enormously. Thus an excellent household coal may be but a poor gas coal, and the converse; a good steam coal adapted for locomotives may be indifferent for furnace-work; and so with regard to all. Coals consist of carbon, with a certain admixture of hydrogen, and some oxygen and nitrogen. There is also a certain quantity of siliceous and earthy matter forming the ash. Coals that consist of pure or nearly pure carbon, require so strong a draft to keep up combustion, and give out heat so intensely at a short distance, that they require very peculiar contrivances for using them economically, and thus anthracite, as such coal is called, has but a local reputation. Cannel-coal, again, yielding an enormous quantity of gas, is by no means economical fuel for the open fire of an ordinary grate, or for a steam furnace. The heat is not sufficiently concentrated. Coals yielding a large quantity of ash are, in like manner, undesirable, for much of the caloric produced by combustion is wasted in keeping the earthy ash at a red heat. Thus the value of a coal must be estimated locally, and is strictly relative, though in general no coal could be considered bad in which the quantity of ash is not more than six or seven per cent., and where the per-centage of volatile substances does not exceed twenty-five per cent., and amounts to ten per cent. With less volatile matter than ten per cent. it is anthracite, and with more than twenty-five it passes into cannel coal. In either case the uses are special. Most of the English and Scotch coals are of sufficiently good quality to be available for general purposes, but the money value varies. The Welsh coals are to a large extent anthracites.

2. *Number and thickness of the seams.* Coal exists in beds of all degrees of thickness, from a tenth of an inch to at least fifty yards. It is evident that there must be a practical limit to economic working, and that under certain circumstances it may be expedient and profitable to work seams that under other circumstances could not possibly pay. When worked by shafts in the ordinary way, it is sometimes worth while to remove coal not more than a foot thick; but this is rarely the case, for so much stone and rubbish has to be moved to mine a seam of this thickness, that the work is not profitable. In

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most districts, however, a two-foot seam, if of fair quality, and not accompanied by very indifferent roof and floor, can be worked, and thus all seams of two feet and upwards are generally calculated among the available coals of a district.

On the other hand, very thick seams involve waste, especially when the roof above the coal is weak, for then coal, often a foot thick, is left, and ultimately lost. In very thick seams, where the coal is of good quality, the works are often conducted in a very wasteful manner, and thus seams from three to six or eight feet thick are perhaps the most profitable, and those least wastefully worked. The number of workable seams in a coal-field varies exceedingly: in the Newcastle coal-fields it is sixteen, in the Lancashire seventy-five.

3. *Depth of workings.* In most coal districts in England the coal seams, although they may once have approached the surface, have long since been worked out to all small depths, and everything that can be got by horizontal tunnels or drifts into a hill-side has been already removed. Pits or shafts have then to be sunk, at a cost and risk varying according to circumstances, and varying so greatly as to give a character of speculation to coal mining that would not otherwise belong to it. When the coal measures (the rocks known to belong to the coal-bearing series) are at the surface, or only covered by gravel and soil, the depth of any particular seam can be calculated pretty closely, especially in a district where there are many pits already sunk. Where this is not the case, and rocks of newer geological date have to be pierced, there is, however, great doubt. This arises from the fact that the exposed surface of the coal series, as of other rocks, has been worn down by air and water, and pared off to a great but unknown extent, during the lapse of the ages that have passed away since they were formed; whereas in those cases in which the measures are protected by a newer rock, they have escaped this, and are probably much thicker. There is also in such cases a possibility of disturbances having altered the dip or tilt of the beds, though generally the deeply-covered beds are more likely to be horizontal.

The present limit of workings in coal mines is not much more than 2000 feet. At that depth in England the temperature is already so high as to be inconvenient, and it is at least probable that, at greater depths, it would be still hotter. It has been found possible to work in mines where the temperature is at least fifteen degrees of Fahrenheit higher than in the celebrated Monkwearmouth pit; but this is by slave labour, and might be impracticable in England. At any rate, it is not likely that, even with improved contrivances for lighting and ventilation, a greater depth than from 3000 to 4000 feet will be attained in coal mines.

4. *The roof and floor.* When a continuous bed, or stratum of coal is removed from the mass of the earth, it is as certain that the rest will come together as that the ceiling of a room would fall if the four walls were taken away. By the ordinary mode of mining this is checked for a time, by leaving walls and props of coal, stone, or timber; but the check is only temporary. It is clear that the amount of fracture of the overlying strata will depend on their plasticity and thickness. Thus, a very thick, hard roof of sandstone may, perhaps, squeeze up a soft floor of clay into the spaces between the walls, and any beds of coal in the overlying strata may not be crushed. If, however, there is the smallest irregularity in the sinking, the coal above will be crushed to powder and destroyed. When the roof and floor are both good, the works of a mine may also be carried on more regularly and more profitably than when they are indifferent; and, as in many cases the most valuable seam of a series lies below two or three others that are somewhat inferior, it may happen that the question of the preservation or destruction of these may depend on the nature of the associated beds.

5. *Water.* In almost every coal district a certain quantity of water, draining naturally to the deepest point, will accumulate in the mines, and require removal by artificial means. Every stratum of the coal series that allows water to percolate will act as a channel; and faults, though sometimes they are "close," and cut off the water, in many instances act as conduits, and help to bring into the mine all the rain-fall of a district.

It is evident that, the deeper the mines, the more will they be subjected to this cause of trouble and expense; but, as all the strata cut through in sinking the shafts can be effectually stopped from entering by a water-tight iron casing to the shaft, it is only the quantity brought in by the coal strata themselves that is troublesome. Perhaps it may safely be assumed that improvements in pumping machinery will render this part of the work of mining as easy hereafter in deeper mines as it is now in those already worked.

6. *Faults and the dip of strata.* The main faults in some of the most important British coal-fields are tolerably well known; but there are many, affecting parts of the coal not yet reached, that may prove very serious. The dip of the coal may also render more difficult, though it may make much easier, the working of the deep coal under the New Red Sandstone. There is reason to believe that none of the coal-fields of Europe are really very extensive, and even the adjoining districts in our own island, though but a few score of square miles in extent, are not capable of any exact comparison with one another. On the other hand, the American coal district of Western Virginia is certainly

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a very large area, and there are others far larger than our own. Beyond their recognized limits many of the British seams appear to thin out and cease altogether. They have been accumulated on or near small islands, and the circumstances of deposit have not been in all cases the same, neither have they been uniformly affected by the forces employed to depress them in ancient times, and afterwards to elevate them. Some seams are horizontal, some at a moderate dip, and some actually vertical.

The reader will now be in a position to advance one step farther, and estimate the probable amount of the stores of coal sealed up beneath the earth's surface, but accessible to human labour.

Let us see, in the first place, what quantity of coal is contained in a given area. An acre of land contains 2840 square yards, and a square mile 640 acres. Each square yard of coal one foot thick is one-third of a cubic yard, and, as a cubic yard of water weighs about three-quarters of a ton, and coal is about one-fourth heavier than water, each square yard of coal one foot thick must weigh $6\frac{1}{4}$ cwt. A square mile of coal one foot thick will therefore weigh $\frac{2840 \times 640 \times 6\frac{1}{4}}{20} = 568{,}000$ tons. If, then, we can obtain an idea of the average thickness of workable coal, and the area under which it can be worked within certain limits of depth, there is no difficulty in calculating the supply.

A careful measurement of the best geological maps, and a reference to the best sources of information, gives the following result for the British Islands:—

Name of Coal-field.	Estimated area in Square Miles.	Possible extension under newer beds.	Estimated total thickness of seams of workable coal
Newcastle and Durham . . .	460	225	30 ft.
Cumberland, Westmoreland, and West Riding of Yorkshire . .	40	20	15 „
Lancashire, Flintshire, and North Staffordshire	380	150	50 „
Yorkshire, Nottinghamshire, and Derbyshire	750	400	40 „
Shropshire and Worcestershire. .	28	20	27 „
South Staffordshire	100	—	45 „
Warwickshire and Leicestershire .	45	120	30 „
Somersetshire and Gloucestershire .	120	100	60 „
South Wales	900	—	84 „
Scotland	1600	500	54 „

Let us now see what our calculation amounts to, and what are the deductions that cause so much difference of opinion in the estimates of intelligent men. With the same figures before them different writers have come to conclusions so exceedingly different that it is worth while to judge for ourselves.

According to the table there are not less than 4500 square miles of exposed coal measures in Great Britain, and at least 1500 square miles of country where coal may be worked with profit beneath overlying formations. Now, if we assume that the general average of total thickness of seams to be fifty feet, which is probably not very wide of the mark, there will appear to be a grand total of $6000 \times 568{,}000 \times 50 = 170{,}400{,}000{,}000$ tons of coal.

From what has been already said, the following deductions must be made from this amount.

In the estimated area is included the whole district on which all the beds crop out, or are believed to exist under cover. Very much of this is not available, and the actual quantity depends on the dip of the bed, the faults, the depth of the seams, and the mode in which the coal seams are distributed. Thus, in some large areas of coal measures there are no workable seams whatever; in others the difficulty of reaching them renders them valueless. A deduction of fifty per cent. must probably be made on these various accounts, if we would ascertain the available supply.

In the estimated thickness the average is intentionally taken low, but it includes all the workable seams. Now, it rarely happens than more than two or three seams are got. The others are more or less injured, or are for the time neglected, and the resumption of workings in an old colliery to take other seams, at first neglected, is known to be a most dangerous and doubtful speculation. Thus it is practically the case that only a part of the average workable thickness is ever obtained.

Next comes the question of waste. It is impossible for those who are not familiar with coal working to understand how very large and serious a matter this is; but the reader will be prepared to recognize some of the causes.

First: there is the waste from poor coal near the outcrop of the beds. This is now unimportant, as few coals are worked near the crop, but it is a considerable deduction from the estimated quantity. Next: there is the deduction for bad coals near and between faults. In this way large portions of a coal-field are sometimes valueless, inasmuch as they do not pay for working. Thirdly: there is waste from the mode of working. A gallery, or drift, as it is called, is cut in the coal when reached, and other drifts at right angles to this, leaving large square columns, which are smaller or larger, according to the

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hardness or tenderness of the coal, and the nature of the roof and floor. On these columns rest the whole weight of the superincumbent rocks—a pressure of a hundred tons to the square foot when the depth is 1600 feet, as is the case in some deep mines. It may well be supposed that this vast weight crushes the coal, and makes it tender. It does not pay to bring up coal-dust to the surface, and thus a large quantity is left behind, besides large parts of the columns that cannot safely be removed. In tender coals the quantity thus lost is very large; the presence of large heaps of small coal, which are often seen burning at the pit mouth, testifies to another cause of waste incident to tender coals, which lose much each time they are turned over.

But these are not the worst causes of waste; there are two others little thought of, but far more serious. The most important is this: thin and poor seams are neglected and destroyed, in order that somewhat better seams a little below may be got first. There could be little objection to this if the seams thus neglected were left uninjured; but this is simply impossible. The descent of the overlying masses into the place of coal worked out always and necessarily involves crushing and fracture of the overlying beds. The coal may not always be, though it often is, broken and rendered powdery, but fissures are opened communicating with the old works, gas and water are introduced, and the seam is partially destroyed. When we see excellent coals three or four feet thick thus utterly and hopelessly destroyed, we are justified in raising a warning cry. This extravagance cannot but have a terrible result; but no one calculates the extent of this loss. To gain a shilling a ton royalty on the coal worked, the proprietor will sacrifice the future interests of his family and the leaseholder his chances of future profits, and thus, where there are twenty feet of workable coal less than ten will be obtained.

The method of working also involves, in many cases, very serious loss; where the coal is thick, and the roof and floor poor or bad, much coal will be left both above and below, and, of course, the whole of this is utterly lost. The large pillars of coal have been already mentioned as producing waste, and the utter absence of mining records in most districts where coal is worked, render it so dangerous to approach old workings that thick ribs of good coal are often left between properties, and where the properties are small the proportion thus lost is not trifling.

Lastly: there is waste so serious and so preventible in the use of coal when brought out of the mine that, in this matter alone, a saving might be effected which would, perhaps, double the time that coal will last in this country. The waste of coal

in smoke is as serious a loss as it is a great public nuisance; coal escaping in smoke is absolute waste, for smoke is nothing more than unconsumed fuel. Sir William Armstrong, in his recent address to the members of the British Association at Newcastle, has alluded to this, and has pointed out how wasteful our use is of this important element of national wealth.

After all, then, what is the probable duration of coal in England? The grand total being 170,400 millions of tons, only one-fourth of this can be regarded as in any sense available, after making all the deductions alluded to, and thus the supply is reduced to 42,600 millions of tons. From this must be deducted what has been already used and wasted, and this is a very important part of the whole in several large districts. It is impossible fairly to estimate more than 35,000 millions as remaining; and, since the present calculated consumption approaches a hundred millions of tons per annum, and is steadily increasing, there is nothing unreasonable in the startling conclusion arrived at by Sir W. Armstrong that, if we go on increasing our consumption and not improving our mining, we cannot calculate on any longer period than two or three centuries to exhaust England as a coal-producing country.

That the estimates made some time ago by Mr. Vivian with reference to the South Welsh coal-field, and since repeated, are enormous exaggerations when regarded in any practical sense, there can be little doubt. But neither is it doubtful that, in that great district, if properly worked, the resources are very great. South Wales may, indeed, be soon called on to replace the northern coal-field, which is giving symptoms of partial exhaustion. The Scotch coal-fields, like those of South Wales, are no doubt capable of great development. It is the more necessary that proper economy of working should be insisted on in these exceedingly important and rising districts, if to these we must look for the continuance of our manufactures.

Economy in mining, as well as economy in the use of coal, a careful abstinence from the terrible and suicidal waste that characterises most of our present coal-fields, and a strict and systematic working of these great sources of our country's greatness, are matters so important and so vital as to deserve every attention from our legislators. Coal and iron are the sinews of a great commercial country; with them we have power of every kind, without them it is not easy to see how the British islands could retain a prominent place among the nations of the earth.

SMOKE-RINGS OF VESUVIUS.

BY CHARLES CH. BLACK, M.A.

HAVING read with pleasure the disquisition on Smoke Rings in No. 16 of THE INTELLECTUAL OBSERVER, I have thought that your readers might be interested in an account of the production of these phænomena on a large scale. In the years 1845-46, I lived in a villa on the hill of the Infrascata, at Naples, from which a full view of Mount Vesuvius was obtained. My attention had been often drawn to a curious effect in the constantly issuing volume of smoke, resembling somewhat the pine-tree spoken of by Pliny in his well-known description of the awful eruption of A.D. 79, but much more regular and gentle, so to speak, than that fearful crest of vapour. This was simply a thin perpendicular stem crowned by an expanded disc, by no means unlike the "umbrella pine" of Italy, so often used in Turner's foregrounds, but more aptly typified as to proportion by the trivial comparison of a juggler's soup-plate balanced on a long pole. This appearance, so far as I could judge, was never manifested but in a perfectly calm atmosphere, oftenest in the stillness of summer dawn, when I have seen as many as three or four of these smoke stems successively disengaged from the volcano's mouth, sailing slowly landwards, and gradually disappearing in the cloudless sky. These discs I afterwards discovered to be smoke-rings, essentially similar in their formation to those produced either from a cigar, a cannon, or from chemical apparatus, and having a mechanic action precisely similar to that so accurately described by your correspondent. Seen from a distance of five or six miles, and a height of several hundred feet, it is easy to understand that they would present the appearance of solid discs, the edge only being visible. My discovery of their real nature happened as follows:—Accompanied by a friend I was in the habit of rambling about the skirts of Vesuvius, frequently ascending to the edge of the crater, and sketching the fantastic masses of lava with which it was gradually and steadily becoming filled. On these occasions we were never attended by guides, and once, on a hot July day, when quite alone, being seated at different points of the crater, we were surprised by a wild noise in the air. The sound was not unlike that of a steam-whistle, but louder and less regular, dying away gradually directly above our heads. We naturally looked for explanation towards the centre of action; nor were we long disappointed. The mouth of the volcano had for weeks, nay months, thrown out with extreme regularity a small jet of stones every

few minutes, and it now appeared, upon watching the action, that occasionally the subterranean explosion and slight tremor which invariably preceded the jet of molten matter were deadened, and, as it were, muffled. When this was the case, they were followed, not as usual, by a shower of stones, but by a huge globe of smoke, which, hurled upwards to a height of several hundred feet, there exploded, and became a true smoke-ring; the contained gas in its escape producing the wild scream which I have mentioned, and the effect of which in the utter stillness and solitude of a summer noon was somewhat startling. We soon found that a little practice enabled us to discriminate with perfect certainty between the eructations which preceded a discharge of *lapilli*, and those which announced another smoke-ring, and came to the following rough theory as to the volcanic action. It would seem that the gas when generated in Nature's laboratory becomes enveloped in a coating or case of vapour. If this coating be of sufficient density to resist the elastic force of the gas till it reach the external air, a smoke-globe and ring are produced; if, on the contrary, the disruption of the envelope take place within the volcano, the gas encountering the mass of light stones which are continually dancing within the throat of the mountain like a pith or glass ball on a fountain-jet, hurls them upward in its effort to escape. The simile of a pith-ball will appear bold even to ridicule when it is remembered that the projected masses are sometimes, though but rarely, larger than an ordinary house. These, however, are so exceptional, that no one would venture to theorize as to the position they may have occupied previous to their ejection from the fiery gulf; the ordinary *lapilli*, varying in size from a hazel-nut to a cocoa-nut or football, may, under favourable circumstances, be actually seen dancing in a thick crust a few feet below the mouth of the volcano. The inward rotary motion of the various parts of the ring as described by your correspondent was very discernible in these colossal specimens, and may, I think, be thus accounted for. The smoke-globe is first torn asunder in its upper portion by the ascending gas, the lower portion is then rent by the influx of atmospheric air, and this current will, in the act of forming the ring, give to its component particles the spinning motion, not inaptly compared by M. Tegetmeier to a ring of buttons rotating on their *axes*. What atmospheric conditions may be most suitable to the production of smoke-rings I cannot say; but I never saw them except in very calm weather, usually, as above-mentioned, before sunrise; and on the last-described occasion, though it was past mid-day, the usual sea-breeze had failed, and the air was hot and stagnant.

HARROW, *October 28th*, 1863.

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THE FIRST JEWISH SHEKELS,

WITH SOME ACCOUNT OF THE SUCCEEDING COINAGES OF JUDÆA, TILL THE REDUCTION OF JERUSALEM TO THE CONDITION OF A ROMAN COLONY, IN THE REIGN OF HADRIAN.

BY H. NOEL HUMPHREYS.

(*With a Tinted Plate.*)

THE class of ancient monuments, known as Jewish shekels, closely connected as they are with sacred history, have long formed a very attractive branch of archæological investigation, but till quite recently the researches connected with their study did not tend to very satisfactory results. While numismatic discoveries had led, in the study of Greek and Roman coins, to valuable and striking illustrations of history, and even to the reconstruction of histories that had been lost, all researches connected with the ancient coins of the Jews proved unsatisfactory, and the conclusions eventually accepted by successive archæologists turned out to be more or less incorrect. As an example of the extraordinary results arrived at, in an over-strained anxiety to find important authentications of the sacred history in the curious coins bearing Jewish emblems, it may be stated that learned men of the first class, such as Scaliger, Bochard, and Morin, ignorant of the ancient form of the Hebrew character, thought they could read the names of Solomon, of David, and many others of the Old Testament on the shekels. Kircher at last succeeded in determining on a coin that had been attributed to Samuel, the true inscription, "Simon, prince of Israel," which was as great a step in numismatic palæography of this class, as was Grotefend's first deciphering of the names of Darius and Xerxes in the inscription of Behistun, towards the interpretation of the cuneatic records of Assyria.

Notwithstanding Kircher's successful first step in the right direction, no further advance was made at that time, and, in fact, until the appearance of the beautiful work of Bayer, "On the Ancient Money of the Jews," many of the learned numismatists of the last century were disposed to consider the coins called Jewish shekels as altogether spurious, mere forgeries by dealers, manufactured for the purpose of trading upon the pious credulity of worthy persons deeply interested in every kind of monument seeming to support by material evidence the authenticity of the Holy Scriptures. The work of Bayer, however, combined with the impetus which it gave to further research, indisputably confirmed the authenticity of the ancient coins called Jewish shekels; though, at that time,

The First Shekels and Subsequent Money of the Jews.

fraudulent imitations were known to be produced by dishonest dealers, as they still are, in considerable numbers.

The general conclusion arrived at with regard to the attribution of these Jewish shekels, after the undoubted proof of the authenticity of genuine specimens, was, that they all belonged to a short period forming the early part of the reign of Simon Maccabæus; he being, it was asserted, the first of the Asmonæan rulers who coined money, in accordance with the concession granted for that purpose by the Syrian king Antiochus VI., after the successful revolt against the Greco-Syrian rule.* The coins bearing the inscriptions, "Simon, prince of Israel," "The first year of the deliverance of Israel," "The second year," etc. etc., seemed to bear out this general view, and many discrepancies were therefore overlooked. For instance, the exceedingly different style of workmanship which distinguished different coins bearing Jewish symbols, was not sufficiently dwelt upon, nor was the weight and size of two or three distinct kinds of silver pieces sufficiently attended to. The first series of suggestions for a reformation of the old classification, was due to the able French archæologist, M. Le Norman; suggestions which M. De Saulcy has since successfully carried out in detail.

The best method of describing the present state of our numismatic knowledge in the attribution of the Jewish series of coins (which are now on all hands allowed to be of unquestionable authenticity) will be to take a summary view of Jewish history from the time of Alexander the Great, about 333 B.C., to the suppression of the Jewish revolt against the power of Rome in the reign of Trajan, about 135 A.D., describing the coins of each period according to the present system of attribution. It is well known that, up to the time of Alexander the Great, the Jews, carrying out in all things the highly conservative character of their constitution, had never adopted the use of *coined* money, but still continued to conduct money transactions by *weighing* the amount of silver paid over in ingots, or smaller pieces, as in the days of the patriarchs. At the period of Alexander's invasion of Asia, the Jews were subject to the kings of Persia, and paid heavy tribute to Darius; but after the battle of Issus, and the signal defeat of the Persian army, Alexander sent a summons to Yaddous, then high priest of Jerusalem, to pay to him the tribute formerly rendered to the Persian king, and also to send him provisions and reinforcements. These demands were refused; probably from a belief that the reverses suffered by the Persian king were only of a temporary nature. But when, after the

* This remark, of course, does not refer to the small later coins belonging to Herod and his race.

taking of Tyre, and then of Gaza, Alexander advanced to the attack of Jerusalem, the local authorities determined to make no resistance, and the chief inhabitants went out to meet him, headed by the high priest, wearing the sacerdotal robes of ceremony. As Josephus* states, Alexander was so much impressed by the venerable aspect of Yaddous, then high priest, that he not only refrained from his intended vengeance, but made a solemn sacrifice on the altar of the temple; and before marching into Egypt, granted to the Jews many privileges and immunities. Among many others may have been that of coining money. This is the more likely, as, previous to the Macedonian invasion, the system of coined money was not generally prevalent in Asia beyond the frontiers of the Greek provinces. The absence of any Asiatic coinage, upon a similar principle to that established by the Greeks, was an inconvenience which Alexander, on penetrating into Asia, at once set about correcting, by causing the treasure acquired in his Asiatic conquests to be coined into money of the Greek form. A vast amount of gold and silver was thus coined; and the staters and tetradrachms then struck were, indeed, so abundant, that they still exist in great numbers, being among the commonest of all ancient coins, and are from their abundance worth little more than the intrinsic value of the metal, except when in very fine preservation. It is, therefore, extremely probable that the Jews were not only permitted, but encouraged, or perhaps commanded, to coin money, which they had never yet done, as they still made use of a metallic medium of exchange, in the inconvenient form of a currency passing by *weight*, and not by *tale*; the pieces of silver, in every money transaction of any importance, being *weighed*, just as they were in the time of Abraham, when that patriarch "*weighed* to Ephron four hundred shekels of silver, current money with the merchant," as the price of the field of Machpelah. The shekel weight of silver had no doubt, originally, a reference to simple barter; and represented very probably the weight of silver which was exchangeable for a lamb, as the denomination for money, used in Job, is not *shekel* but *kesitah* (a lamb). This weight long remained among the Jews that upon which larger amounts were calculated, and therefore became the standard unit which was determined upon when a positive coinage was issued. If the first issue took place, as now supposed, at the time of the conquests of Alexander, there would be an additional reason for adopting the weight of the ancient shekel as that

* Some have doubted this statement of Josephus, in consequence of the event not being mentioned by Arrian. But it may have been omitted by Arrian as not essential to the general history; while to Josephus, as a Jew, it had an especial interest.

of the chief unit of the public money, as it corresponded very closely with the Macedonian didrachm, which formed the bulk of the silver money of Philip II., still circulating abundantly in the reign of his son. The early issues of Judæan money were exclusively silver, the Jewish terms for *money* and *silver* being, in fact, synonymous, as with the modern French, who, like the ancient Jews, have no other term for money than *argent;* even gold or copper money being equally *de l'argent.* Shakespeare did not, therefore, prove himself a learned numismatist when he spoke of "shekels of the tested gold;" as no gold shekels, as coins, ever existed. Supposing the first issue of Jewish coins to have taken place during the supremacy of the high priest, Yaddous, it is natural to suppose that the types adopted would be of a strictly religious character, forming a kind of public declaration of the national faith, which had just re-asserted itself under the protection of Alexander, after having been discountenanced as much as possible both by the Assyrian and Persian rulers of Judæa.

Among the coins formerly attributed to Judas Maccabæus are a certain class, the size and thickness of which, combined with the bold, broad, and simple execution of the devices, mark them out as belonging to a different epoch to the others. The greater thickness, and slight convexity in the middle, combined with the style of art of the types, at once suggest a general similarity of workmanship to that of the Greek coins of the Alexandrian period, especially those of the neighbouring Greek cities of Ephesus and Damascus. It is these pieces, therefore, that have now been assigned to a coinage supposed to have taken place under the auspices of the high priest, Yaddous, at the instigation of Alexander the Great. Coins thus issued would naturally be expected to bear some allusion to the unexpected liberation from the Persian thraldom which had recently taken place; and we find, in fact, on the coins which have now been assigned to this epoch, the inscriptions, "first year," "second year," "third year," and "fourth year of the liberation of Israel." There is thus every reason to consider the attribution correct; although it gives to the Jews the credit of a monetary issue similar to that of neighbouring nations nearly two centuries earlier than was previously supposed.

The engraving (Fig. 1) is taken from one of these coins, a silver shekel, bearing the numerals of the second year. The obverse has for device a branch bearing three flowers, in allusion to the twelve rods or sceptres which were ordered for the twelve tribes, and placed in the arch of the temple, the rod bearing the name of Aaron being found in the morning covered with leaves and almond flowers. The style of the letters of the inscription are additional proof of the

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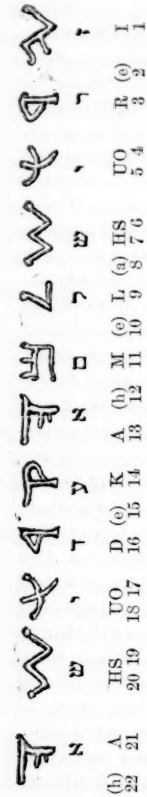
correctness of the present attribution of these coins to the epoch of Alexander, as they closely resemble in style the treatment of the letters of Greek coins of the period, particularly in the little knob or pellet by which all their main lines are terminated. The inscription is in the ancient Jewish character,



commonly known as the Samaritan, which was used for all national and monumental purposes long after the common Hebrew letters, acquired during the captivity, had been in general use for ordinary purposes. The inscription reads, beginning at bottom of the right-hand side, and reading upwards, *Jeroushalem ha kedoushah*, Jerusalem the Holy. The vowels, omitted after the manner of all early oriental systems of writing, are not supplied by *points*, as in the later Hebrew, which renders some of the inscriptions very difficult to read; but those of the coin under description may be easily followed, on reading it from right to left in the usual Hebrew manner, as in engraving, and comparing it with the common Hebrew and English letters, between which the omissions of aspirates and vowels are supplied within brackets; the whole of the English letters, double letters, and vowels being numbered, to mark unmistakeably the order of succession in which they are to be read.

On the reverse, the type consists of a vase, said by some numismatists to represent the sacred cup called *Omer*, filled with manna, in allusion to the following passage in Exodus xvi. 32: "And Moses said, This is the thing which the Lord commandeth, Fill an omer of it to be kept for your generations, that they may see the bread with which I fed them in the wilderness." Above the cup are the two letters *Schin* and *Beth*, expressing "second year," the first being the initial of *Shinath* (year), and the second being *Beth*, the second letter of the Jewish alphabet, used as the numeral 2 by the Jews, who, like the Greeks, adopted the letters of their national alphabet, in their regular order, for their numerals. The inscription of the reverse, which may be read by the aid of the explanation above, is S h (e) k (e) l I sh r a (e) l, Shekel of Israel.

The high priest, Yaddous, lived ten years after the granting of the privileges referred to, dying about the same time as

Alexander, in 323 B.C. But no money appears to have been issued after the fourth year of the new *regime*. This circumstance is by some considered to invalidate the attribution of these coins to the epoch of Yaddous; yet when it is considered that an immense drain upon the resources of all the tributary provinces took place during the last six or seven years of the life of Alexander, to meet the vast expenses of the campaigns in the far east, it is not astonishing that the Jewish treasury became exhausted after the fourth year, and that no more coin was issued. This view seems borne out by the fact that the coins of the fourth year, though stamped as shekels and half-shekels, are only copper—the substitution of the baser metal betokening a period when the country had already been drained of its silver.

We next come to the coinages which may fairly be attributed to the Maccabæan dynasty. After the death of Alexander Judæa fell under the dominion of one or other of the dynasties established by the generals of Alexander, who erected for themselves independent kingdoms out of the vast Macedonian empire which he had founded. At one time Judæa was possessed by the Greek kings of Egypt, Ptolemy Lagus, and his descendants; while at another it fell beneath the sway of the Seleucidæ, the descendants of Seleucus Nicanor, who first established the Grecianised kingdom of Syria; and this state of things deprived the Jews of almost every vestige of national life. Greek manners and the Greek language prevailed, and the Judaic identity seemed likely to be crushed out; but it was not so destined. The last attempt of the Greek sovereigns of Syria to thrust the religion and language of Greece upon the subjugated Jews, produced a re-action and revolt, which resulted in the temporary re-establishment of Jewish independence. The statue of the Greek Zeus, or Jupiter, had been placed in the temple by Antiochus IV., and the high priesthood had been sold to renegade Judæans; first to a certain Joshua, who assumed on the occasion the Greek name of Jason, and then to Onias, who changed his name to Menelaus, and, to raise the necessary money for purchasing his appointment, sold the sacred vessels of the temple. The Samarians had, in the meantime, accepted the Greek faith without scruple, and set up a statue of the Hellenic Jupiter in their temple. Antiochus IV. next proceeded to publish an edict directing uniformity of religious worship throughout his dominions, and a revolt in Judæa immediately followed this last and most oppressive edict, which threatened the Jewish faith with utter extinction. At Modin, a small town near Lydda, Mattathias, a Jew, a man of priestly race, refused, in 170 B.C., to obey the injunction of the king's agents appointed for the establishment of the religious

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faith of the Greeks, slew the principal officer with his own hand, and retired to the mountains with his five sons, John, Simon, Judas, Eleazar, and Jonathan. Being there joined by great numbers of insurgents, a permanent and serious resistance was offered, and the national independence was partially re-established, after a series of signal successes against the Syrian troops. He was the great-grandson of Asmonæus (or, in the Hebrew form, Chasmon); and, in consequence of this descent, his successors became known as the Asmonæan dynasty.

Mattathias died about 170 B.C., in the first year of the revolt; and though no coins can at present be attributed to him, it is probable that some were issued, and may yet be brought to light, as he would, doubtless, have been anxious to put forth such an evidence of the independent sovereignty which he had established. Coins bearing the name of Mattathias, and which were formerly assigned to him, have now been proved to belong to his descendant, Antigonus, as will be shown further on.

He was succeeded by his son Judas, who, after two decisive victories, entered Jerusalem in triumph, during a Syrian civil war which broke out on the death of Antiochus. He eventually fell in a battle, overwhelmed by numbers, in 161 B.C. Coins quite recently discovered are now attributed by M. de Saulcy to Judas Maccabæus,—they are small copper, and only two specimens are as yet known. These coins are of poor workmanship, and exhibit that degradation of art which was sure to follow such political convulsions as were at the time leading to the rapid dissolution of the great Syrian empire of the Seleucidæ, and the disturbances caused, at the same time, by the struggles of the Jews to establish their independence. The device of the reverse consists of two horns of abundance; and this type thenceforth became a sort of family badge or device of the Asmonæan dynasty. The engraving (Fig. 2) is from the coin recently discovered near Jerusalem, which has, with every show of probability, been attributed by M. de Saulcy to Judas Maccabæus. The inscription should read, *Jehoida Cohen*—"Judas, the high priest"—followed by the titles "illustrious" and "friend of the people."

It has been suggested that the cognomen of Maccabæus is derived from the Hebrew *Maccab*, a hammer, in allusion to the heavy blows inflicted on the Syrian army in the course of his rapid and decisive victories; just as in our own annals Edward I. was termed *Malleus Scotorum*, "the hammer of the Scots," a title inscribed on his tomb in Westminster Abbey. Other archæologists have, however, asserted that the name was assumed in consequence of the Hebrew letters, M. K. B. E. borne on the standard of Judas, which were, in the Hebrew,

the initials of the passage in Exodus (xv. 11)—"Who is like unto thee, O Lord, among the gods?"

Jonathan nominally succeeded his brother Judas in 167 B.C.; but as the Syrian forces after the death of Judas obtained possession of nearly the whole of Judæa, he was compelled, with his brother Simon, to act entirely on the defensive; and, about this time, the other remaining brother, John, fell in battle. The increasing confusion caused by various pretenders to the Syrian monarchy were, however, favourable to Jonathan, and he not only regained the independent position formerly held by Judas, but was influential in bringing the affairs of Syria to a temporary settlement; he was treacherously assassinated in the year 144 B.C. There are small copper coins now attributed to Jonathan very similar to those of his brother Judas; the coins of both being very late additions to the series, though Barthelemy had already deciphered the name of Jonathan in 1749. The inscription is of similar import to that on the coins of Judas. The representation (No. 3, in the plate) is from the engraving published by M. de Saulcy. The inscription reads Jehounathan, with the title of "high priest," and also that of "supreme," and "friend of the Jews." The engraving is larger than the real coin, in order to show the inscription more distinctly.

Simon succeeded his brother Jonathan in 144 B.C. He was on the whole the most steadily fortunate of the five sons of Mattathias, and eventually drove the Syrian garrison from the citadel of Jerusalem, thus establishing the entire independence of the capital, and also of the greater part of Judæa. It was to Simon that Antiochus, the son of Demetrius, formally conceded the right to coin national money, as related in the Chronicles of the Maccabees, thus acknowledging the independence of Judæa as a distinct state. When, therefore, modern numismatists first succeeded in reading the inscriptions on the Jewish money, and coins were actually found with such legends as "Liberation of Zion," "The Liberation of Jerusalem," and, above all, "Simon, prince of Israel," with dates such as "the first," "the second," "the third," "the fourth year of independence," it was natural that they should be attributed to Simon, the brother of Judas Maccabæus. The Jewish coinage has, however, as previously stated, been recently distributed in such a way that not a single well-authenticated coin is now attributed to the last and greatest of the sons of Mattathias. It is, however, most probable that he did issue coins, and that specimens of them will yet be discovered. Simon was treacherously assassinated by his son-in-law, Ptolemy, governor of Jericho, in the year 135 B.C.

John Hyrcanus, the son of Simon, succeeded his father,

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and though he did not assume the title of king, he reigned as an independent monarch for twenty-nine years. The coins he issued bear the dynastic type of the two horns of plenty established by his uncles, Judas and Jonathan. The name within the wreath on the obverse is spelt Jehouhanna, followed by the usual titles; and the Greek A above the Hebrew inscription has been explained as the initial of Antiochus Sidetes, with whom and John Hyrcanus an alliance existed in 134 or 135 B.C. No coins but those of small copper are known of this prince. He died 106 B.C. The coin engraved at No. 4 has been attributed to John Hyrcanus, though the inscription does not agree with those engraved by M. de Saulcy.

Aristobulus (Judas Aristobulus) succeeded his father, and was the first of the Asmonæan dynasty who assumed the name of king. He only reigned one year, dying of an illness aggravated by remorse for having put to death his mother, who had been left regent of the kingdom by Hyrcanus. Small copper coins, similar to those engraved at Figs. 2 and 4, have been attributed to Aristobulus. Others, with Greek letters, forming part of his Hebrew name, written as IOϒΔA, etc., are now attributed to him, and are the coins previously alluded to which were formerly assigned to the first Judas Maccabæus.

Alexander Jannæus (Jannæus being a corruption; his native name Jonathan), another of the sons of John Hyrcanus, succeeded his brother Aristobulus, and reigned from the year 106 to 105 B.C. It will have been seen that the custom of adding a Greek name to the national one had then become a fixed custom, and that throughout Judæa the Greek element of civilization, at that period, was so strong that the foreign name, and even foreign types, were placed on the national coin; for the coins of Alexander Jannæus do not bear, in the specimens yet known, the usual Asmonæan type, but in its stead the well-known Syrian emblem of the Seleucidæ, the anchor, implying perhaps a close alliance with one or other of the princes of the Syrian family. Alexander Jannæus died in 78 B.C., after a tempestuous reign, bequeathing his kingdom to his widow.

Alexandra reigned from 78 to 69 B.C. Her coins have legible Greek inscriptions round the anchor type; but the Hebrew legends have not been deciphered.

Hyrcanus II. This feeble prince succeeded his mother Alexandra, but was displaced by his brother, Aristobulus II., which led to that appeal to the Roman power, already predominant in Syria, which ended in the taking of Jerusalem by Pompey. The Roman commander reinstated Hyrcanus, carrying off Aristobulus prisoner to Rome. Further troubles led

to the plunder of the temple and its sacred treasures by Crassus, then holding the chief command in Syria. Hyrcanus, who had been left in the government of Judea by Pompey and Crassus, but only with the title of high priest, received back his title of king from Julius Cæsar, in return for services rendered during the Egyptian war. Hyrcanus had betrothed his daughter Mariamne to Herod, the son of Antipater, who had been appointed governor of the newly-subdued province of Idumæa. The influence of Herod rapidly increased after this alliance. His military talents, and general capacity for government, were of a high order, and he eventually usurped the throne, Hyrcanus being put to death. There are doubtful coins both of Aristobulus II. and Hyrcanus II., those of the latter bearing the original Asmonæan inscriptions and types.

Antigonus, a son of Aristobulus II., succeeded with the aid of a Parthian army in driving the usurper Herod out of Judæa. Flying to Rome, however, Herod obtained, through the influence of Antony, a recognition of his assumed title of King of Judæa. Antigonus endeavoured to defend himself; but Herod, supported by Sosius, a lieutenant of Marc Antony, took Jerusalem after an obstinate siege, and Antigonus, the last of the Maccabees, who surrendered himself to the Roman general, Sosius, was sent to Antony, then at Antioch, who ordered the unfortunate prince to be executed as a common malefactor, in the year 37 B.C. Most of the coins issued by Antigonus have for principal type a single horn of plenty, with the legend *Kohen Gadol* (illustrious and high priest?) in old Hebrew character; and on the other side (in Greek characters) the name of Antigonus, abbreviated, with the title of king, as shown at Fig. 5. Antigonus also bore the national name Mattathias, in honour of the founder of the dynasty; but the Roman and Greek interests combined had thrown the Jewish characteristics into the shade, and the once honoured name of Mattathias does not appear on the national coin as the native name of the last of this line of native princes.

Herod, surnamed the Great, lifted to the chief power in Judæa by the influence of Marc Antony, issued coins which have still more or less of the character of those of the Asmonæan race. Some of these, all small copper, have even the type of the two cornucopiæ. Others, issued before he was allowed by the Roman authorities to assume the title of king, bear that of tetrarch. Many foolish fables once existed respecting some of the types of the coins of Herod; among others that the star, a Syrian emblem used by some of the Asmonæan princes, was the "star of Bethlehem," though certainly the last emblem in the world likely to be adopted by the first enemy of Christianity. The most common types of the coins of Herod are the helmet,

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the Syrian anchor, the bunch of grapes, etc. The death of Herod, which, actually, occurred in the same year as the birth of Christ, would appear to have happened four years before, according to the commonly accepted Christian era; and it is assumed that he may have been urged to the slaughter of the children of Bethlehem, recorded by St. Matthew (but not mentioned by Josephus, or any other contemporary historian) by the last pangs of the painful and irritating disease of which he died. This has been assumed, because such an act of gratuitous cruelty appears inconsistent and consequently improbable; but when it is considered how many of his own children he put to death, in consequence of idle suspicions and jealousies, he seems to have been fully capable of such an act, if he had deemed it politically advisable—an estimate of his character widely prevalent in his own day, as we learn from the well-known exclamation of Augustus, when he heard of the political murders of Herod's two sons, Alexander and Aristobulus, who had been brought up at the Court of Rome—"Better to be the hog of Herod than his son," said the emperor—*Melius est Herodis esse porcum quam filium*..

By the Will of Herod vast sums in money, and gold vases and jewels of great value, were bequeathed to Augustus, and his territories were divided between his sons, Archelaus and Antipas. Each claiming the whole dominions of their father, both proceeded to Italy to lay their claims before the Roman Emperor, who confirmed in all its main features the will of Herod, giving the tetrarchies of Galilee and Peræa to Antipas, while Archelau sbecame ethnarch of Judæa, with a promise of the eventual title of king. After a reign of ten years, however, Antigonus was convicted of cruelty and deposed by Augustus, A.D. 7, and died in exile at Vienne, in Gaul. He issued small coins similar in general character to those of his father. The most usual have the prow of a vessel, the Syrian anchor, or a helmet, and a Greek inscription round the type. The name is generally abbreviated, as ΠΡΩ, and the title of ethnarch as ΕΘΝ. After his expulsion Judæa was made a Roman province, and Annius Rufus appointed imperial governor.

The Roman procurator, Copponius, had already issued a provincial coinage for the use of Judæa, bearing date the year 31, after the Battle of Actium, and coins of the same class were most probably struck by Annius Rufus, as ascertained by the date, Λ. ΓΘ (for Λυκαβας Γο). The Romans, in their eastern provinces, dated their public records, and the coinage, from the Battle of Actium, which first placed Egypt and the regions of Asia bordering on the Mediterranean directly under the imperial government. That event took place in the year 31 B.C.;

so that the date on the coin issued by Annius Rufus, and bearing the Actian date, "year 39," corresponds to the year 8 A.D. The type of the obverse of this coin (Fig. 6) is a palm tree, with the inscription ΚΑΙΣΑΡΟΣ (of Cæsar), implying money of Cæsar. The palm tree, which we find here acknowledged by the Roman authorities as the national symbol of Judæa, we shall afterwards find used as a principal type on the coins issued by the revolted Jews in the reign of Nero, and again on those issued during the great revolt in the time of Hadrian.

The first procurators of Judæa were not allowed a very lengthened enjoyment of office, and in the year 26 or 27 A.D., Gratus, the fifth procurator, was superseded by Pontius Pilatus, who was appointed by Tiberius, in the year 27 A.D., and held the office for ten years. The provincial coins issued by these successive procurators may be assigned to each by the aid of the Actian date, and specimens bearing Actian dates between the years 58 and 68 of that era may be considered to have been issued under the auspices of Pontius Pilate. Pilatus, as is well known, was deposed for peculation and other abuses of power, in the last year of the reign of Tiberius, 37 A.D., and died in exile.

Herod Antipas had continued tetrarch of Galilee and Peræa, after his father's expulsion from Judæa, and it was in consequence of his being accidentally in Jerusalem, then entirely under Roman rule, that Christ was sent before him as belonging to his jurisdiction, on account of his supposed Galilean origin. It was also Herod Antipas who ordered the execution of John the Baptist, because he had blamed his unlawful marriage with Herodias. After the accession of Caligula, in 37 or 38 A.D., Antipas went to Rome to solicit the empty title of king, which had just been conferred on his nephew, Herod Agrippa. But Agrippa, who had been brought up in Rome, was a great favourite with the Emperor, whose youthful companion he had been, and who, therefore, unjustly conferred upon him the dominions of his uncle Antipas, in addition to the tetrarchies which had already been conceded to him, while Antipas was banished to Spain, and died in exile. Small copper coins are attributed to Antipas, most of which bear the title of tetrarch.

Herod Agrippa (in the year 37 A.D.) received from Caligula the tetrarchies of Philippus and Lysanias, with the title of king; and afterwards the tetrarchies of Galilee and Peræa. On the death of Caligula, Agrippa, being in Rome at the time, greatly aided in placing Claudius upon the imperial throne, and obtained in return the provinces of Judæa and Samaria as additions to his kingdom, which thus became more extensive than that of Herod the Great, while at his request the little district of Chalcis was conferred upon his brother Herod, also with the

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title of king. Agrippa immediately commenced fortifying Jerusalem in a manner which would have rendered it impregnable, but the works were arrested in consequence of the aroused suspicions of Claudius. His government was generally characterised by mildness; he had interceded with Caligula on behalf of the Jews, when they opposed the determination of that emperor to set up his own statue in the temple; and yet, to court popularity in Jerusalem, he consented to the death of the apostle James, the brother of John, and cast Peter into prison. He died at Cæsarea, the seat of government of the former procurator, as related in Acts xii., at the age of fifty-four, in the year 44 A.D. There are coins of this prince which have for type a kind of portable canopy or sun-shade, an oriental emblem of power, or, as described by some, a tabernacular emblem. The inscription is ΒΑΣΙΛΕΩΣ ΑΓΡΙΠΠΑ, "of the King Agrippa." These coins are, however, of uncertain attribution, and are by some assigned to his son, Agrippa II.

Herod Agrippa II. On the death of Herod Agrippa, his son Agrippa, who was being educated at the court of Claudius, in Rome, was only seventeen years of age, and a Roman procurator was therefore appointed to the government of Judea and the annexed provinces. The care of the temple of Jerusalem, and the power of appointing the high priest, were, however, confided to a native prince, the brother of the late king, who was still sovereign of the petty state of Chalcis. In A.D. 48, after the death of Herod of Chalcis, the principality of Chalcis was conferred on Herod Agrippa II., with the same privileges in regard to the superintendence of the temple and the appointment of the high priest. Several additions were afterwards made to the districts placed under his jurisdiction. It was before this Agrippa that St. Paul defended himself against the charges of the Jews. Agrippa being at Cæsarea, the seat of government of the Roman procurator, he was appealed to by Festus, as a native prince well acquainted with Jewish history and customs, and to this circumstance Paul refers when he expresses his satisfaction at pleading his case before him, especially, as he says, "Because I know thee to be expert in all customs and questions which are among the Jews." The Jews became at this time impatient of their dependent condition, on account of the heavy taxes extorted by the Roman governors, and Agrippa in vain attempted to dissuade them from rebelling against the power of Rome. On the breaking out of the insurrection, he sided with the Romans, and after the fall of Jerusalem retired to Rome, where he received the rank of prætor, and died there in the seventieth year of his age, in 98 A.D. It is difficult to

distinguish the coins issued under his authority from those of his predecessor of the same name. He was the last prince of the Herodian line.

This insurrection of the Jews, which broke out towards the close of the reign of Nero, notwithstanding the efforts of the last of the Herodian princes to prevent it, was principally provoked by the tyranny of Florus Gessius, who had succeeded Albinus as procurator of Judæa. The Jewish coins illustrative of this epoch are quite a recent numismatic discovery, for which archæologists are indebted to the perseverance and skill of M. de Vogüe. They have for types a branch of palm, and various other national types, but always avoiding those of the Asmonæan, or Herodian race of kings. The petty tyranny of the last native kings, though restricted both as to territory and regal privileges, had been in fact so distasteful to the Jews, that they had even petitioned, under Herod Archelaus, the son of Herod the Great, that Judæa might be annexed to the Roman province of Syria. It may be easily imagined, therefore, that the monetary types of the Asmonæan and Herodian dynasties had become distasteful, and that the more ancient native types, similar to those used on the first Jewish coinage, issued by the high priest Yaddous, should be preferred. The Jewish coins struck during the revolt against Florus bear the name of Eleazar, who had been elected high priest by the insurgents, and had assumed the sovereign privilege of coinage. There are a whole series of coins, of both silver and copper, bearing this name, with inscriptions in which the ancient character was again adopted. The obverse of the coin (Fig. 7) is one of this series, and has for type a one-handled vase with an inscription, which, in modern Hebrew, should read אלעזר הכוהן, "Eleazar the priest." The reverse has a bunch of grapes; but many other types of a similar class occur in other specimens, bearing this name, all of which are superior in workmanship to those of the first Maccabees.

Gallus, the governor of Syria, having gone to the assistance of Florus at the beginning of the rebellion, and having sustained a disastrous defeat, Vespasian, then merely a popular general, but known for his skill and determination, was sent out to quell the revolt. During his prosecution of the war, which became a very serious one, the death of Nero took place, and, after brief possession of power, that of his successors, Otho and Vitellius, also. Vespasian being elected emperor while still directing the operations of the Roman army in Judæa, transferred the command to his son Titus, who eventually reduced the city on the 8th of September, A.D. 70, after one of the most obstinate and desperate defences on record.

After the taking of Jerusalem, Titus issued a provincial

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coinage of copper for the use of Judæa, somewhat larger and different in character to that of the procurators. These coins bear the name and titles of the issuer abbreviated, as AVTOKP TITOΣ KAIΣAP; and also the inscription, IOTΔIAΣ EAAωKIAΣ, in allusion to the complete subjection of the Jewish people. But the most remarkable coins issued on this occasion were those struck in Rome by order of the Roman senate, which are among the most interesting of the whole Roman series. The reverse (Fig. 8) represents Titus in a posture of triumph, placing his foot upon a clod of earth, symbolizing the subdued territory, while a personification of Jerusalem, as a female figure, wearing a turretted crown, weeps, in a dejected posture, beneath a palm, the national type of Judæa. This device is accompanied by the inscription, "Judæa Capta," which at once removes all doubt concerning the true meaning of this interesting allegorical composition.

After the year 70 A.D., all signs of an independent kingdom were obliterated. The last of the native princes, Herod Agrippa, though he had sided with the Romans after the breaking out of the revolt, was compelled to retire into private life; and great obscurity prevails over the events which took place in Judæa, as a Roman province, from the year 70 A.D. to the year 117. In that year, at the time of the death of Trajan, Hadrian was at Antioch; the affairs of the East being then in a disturbed state, which all the energy and military talents of his predecessor had not been able to quiet; among other difficulties, Syria and Judæa were in a state of quasi insurrection, though it was not till the year 131, and after an intervening period of comparative repose, that the last serious revolt took place. Most of the ancient Jewish privileges had been abolished, one after another, as it was thought by the Roman authorities that the observance of ancient customs, and especially of religious festivals of peculiar character, tended to keep up and nourish feelings of nationality and independence. Among the customs forbidden was the rite of circumcision; but it is stated by some authors, and among others by St. Jerome, that a determination on the part of the emperor to make the city of Jerusalem a military fortress, and the seat of a Roman colony, under a new Roman name, more greatly than any other grievance, tended to stir up a serious revolt. That a revolt took place at this time is well known, and there are certain coins, bearing national Jewish types and Hebrew inscriptions, which M. de Saulcy attributes to the first years of this rebellion, before the election of Simon Barcocebas (one of the leaders of the revolt) to the chief power, as high priest and prince of Israel. The coins so attributed by M. de Saulcy are similar in type to those afterwards issued by Barcocebas during the

temporary independence secured by the revolt, but they have only for inscription, "The liberty of Jerusalem," and "Year 1 of the deliverance of Israel," and no name. Barcocebas, or more correctly, *Bar-kaou-kab* (the son of star), becoming the sole director of the revolt, it assumed under his command important dimensions, and he rapidly made himself master of 50 fortresses and 985 villages, which called serious attention to a revolution which had not at first created much alarm. Barcocebas, after these successes, assumed the title of king, and also of Messiah, continually styling himself "prince of Israel," on that fine series of coins issued by his authority, which were formerly attributed by numismatists to the glorious reign of Simon Maccabæus. Their present assignment to Simon Barcocebas appears fully justified by their general character and appearance, which differs entirely from that of the Jewish coins of the Maccabæan period. Their workmanship bears a close resemblance to that of the Romano-Egyptian coins of the period of Hadrian, both in a peculiar solidity of make, and also in a liny rigidity of outline exhibited in the devices. The types are of analogous character to those of the ancient shekels of Yaddous, and the inscriptions bear a similar import, proving that the very first emission of national money, under the protectorate of Alexander the Great, still possessed more pleasing associations than the subsequent issues of the native princes.

The larger silver coins of the issues of Barcocebas appear to be tetradrachms or double shekels. Their weight, however, corresponds more accurately to that of Roman denarii, the large pieces being of the weight of four. The one engraved (Fig. 9) is of the well-known "Temple" type, in which the oriental character of the capitals and bases of the columns are very peculiar, resembling those of the Persian architecture of the Alexandrian period, which may be an allusion to the original temple, and not to the building then existing, which, as Josephus informs us, had been partly rebuilt by Herod, who, in his restorations, employed the Corinthian order. The inscription, part of it being on each side of the columns, appears to read "Simeon," Barcocebas having doubtless assumed the still popular name of the celebrated Simon Maccabæus. The type of the reverse is an ornamental bunch or bouquet of flowers and branches, called *loulab*, such as was carried by the priests in the Feast of the Tabernacle, and by the side of it is a cone of cedar, the inscription being, "Lecheruth Jeroushalim," ("to the liberty of Jerusalem,") with numerals expressing the year 2 of the liberation, after the manner of the coins of Yaddous. Among a number of other types, all having reference to the national and religious institutions, those of the copper coins engraved are as interesting as any.

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On the obverse of some of them (see Fig. 10) is the national emblem of the palm, as it appeared on the famous Roman sestertius of Titus. This type is accompanied by the name "Simeon," which has sometimes the addition "Nassi Israel," prince of Israel. On the reverse of this type is a vine leaf, the inscriptions accompanying which are various. The same types also occur on silver coins.

The best of these coins are of very superior workmanship in their peculiar style, and their size and general character make them a fitting climax to the numismatic history of Judæa. Barcocebas was not joined by the Christians of Jerusalem in consequence of the great cruelties which he perpetrated, by which he lost a very important element of possible success. Nevertheless, the rebellion was not subdued till the popular commander, Julius Severus, had been called from Britain to lead a new army against the Jewish insurgents. As the rebellion drew to a close, coins of a very inferior character were issued, some of them being, in fact, Roman denarii, over the devices of which the Jewish symbols and inscriptions were stamped, in many cases the original workmanship of the Roman coin being still discernible. The types of a large copper coin of unusual size, bearing the inscription, "Simon, prince of Israel," and year 1 of the redemption of Israel, appears to have been struck over an old Roman sestertius of the early period of the empire, before the size of the Roman large copper was reduced.

These last-named coins, which finally close the Jewish series, were at one time the only coins attributed to the epoch of the revolt of Simon Barcocebas.

The insurrection being finally and completely subdued, a Pagan temple was erected in a conspicuous situation, and statues of Jupiter and Venus stood on the spot where the crucifixion of Christ had taken place, while Jews were forbidden from any longer inhabiting Jerusalem, which was at once converted into a Roman colony under the title of Colonia Ælia Capitolina, in honour of Hadrian's prenomen, Ælius. Roman coins of this colony, of precisely the same class as those of other Roman colonies, were struck on the occasion, and similar coins were issued during the reigns of succeeding emperors. A tolerably complete series exists up to the reign of Trajanus Decius, and, with some omissions, even to the time of Hostilianus, during which long period the name of Jerusalem was as it were obliterated, and that of Ælia Capitolina adopted in its place.

Before closing these remarks on the ancient coinage of the Jews, it may not be amiss to put travellers in the East on their guard against purchasing at extraordinary prices the coins that will be offered to them while at Jerusalem, as being found in

recent excavations. Most of these are only casts or electrotypes from the real coins, having a certain interest as true copies, but not to be paid for as originals. It may also be interesting to exhibit an engraved specimen of the clumsy forgeries of Jewish coins which deceived the numismatic amateurs of the last generation, and for which purchasers are still found among the unwary. The specimen engraved (Fig. 11) belongs to the Messrs. Groombridge, who have kindly lent it for this occasion.

The examination of the obverse alone will be sufficient to exhibit the wretchedness of such attempts at falsification. The type is a vase of quite modern fashion, the handles and other parts being ornamented in the most paltry style of the last century, instead of having the severely simple character of the *Omer* of the ancient shekels (engraving No. 1), which it is intended to imitate. The smoke or incense issuing from it, a most unmeaning addition, is also treated in a flat, unartistic, and modern feeling. But the great and fatal mistake of the forger is the inscription, "Shekel Ishrael," in which the modern Hebrew letters are used instead of those of the ancient alphabet, which was always employed for monumental and other public purposes in Judæa, especially for the coinage, even after the later kind of writing had been long generally prevalent as the popular style. Some of these forgeries have been made to bear the name of Solomon, David, or even Samuel, though it is well known that no Jewish coin of any kind was issued previous to the epoch of Alexander the Great, several centuries after the time of Solomon; and that no Jewish coins bearing the *name* of a prince or high priest were issued till the comparatively late period of the Maccabees.

Many other coins, illustrative of Judæan history, might easily have been added to those described above, were it not that the article has already assumed dimensions of far greater extent than was originally intended.

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CLUSTERS, NEBULÆ, AND OCCULTATIONS.

BY THE REV. T. W. WEBB, M.A., F.R.A.S.

NEBULÆ.

We opened our list with a promise of glorious and wonderful objects of contemplation, and our readers, we believe, will not have found themselves hitherto deceived by overwrought expectations. We cannot ensure them a continuous succession of scenes of equal interest and wonder; our next, however, will be little inferior to its great predecessor; and those accustomed to a search after obscure and difficult objects will readily adopt the epithet of "overpowering," which Smyth has so characteristically applied to it. It is

3. *The Great Nebula in Andromeda.* Being readily visible to the unarmed eye, in consequence of its brightness and extent, it will give but little trouble in the finding. Having first identified *β Andromedæ* from the directions following No. 63 of the Double Star list (Int. Obs., vol. ii., 374), we shall perceive that this star is the lowermost of a short line of stars tending in a *n p* direction: of these the next to *β* is *μ*; the third is *ν*; and a little *p*, or to the right of *ν*, the nebula will be immediately recognized by its misty aspect. It is so conspicuous that, like the nebula in Orion, it is singular that it should have found no place among the "Nebulosæ" of the ancients. It was, however, perceived before the invention of the telescope, being represented in a diagram whose date seems to have been towards the close of the 10th century.* Tycho Brahe, strange to say, makes no mention of it, though he carefully observed the adjacent stars; and no further reference to it occurs till 1612, Dec. 15, when Simon Marius first, as it would appear, viewed it with the telescope, and gave a very good account of it. This, however, seems to have drawn little attention, as the great observer Huygens was ignorant of its existence even in 1659; but in 1664 the passage of a comet through that region was the means of bringing it finally into general notice. For a length of time subsequently it was so differently described by different observers, that Le Gentil,

* Herschel II. and Smyth have given A.D. 905; upon what authority does not appear; but from Bond's statement it would seem to follow that this is a misprint for 995. Bond in turn has misprinted 1662 for 1612, and the Latin title of one of Bouillaud's treatises, as cited by him, contains several strange errata. He is also mistaken in supposing that no intimation of its having been seen is to be found between 1612 and 1664, as Smyth tells us that Bouillaud, in 1667, mentions its having been noticed 150 years previously by an expert though anonymous astronomer.

about the middle of the last century, was led to conclude that it must have varied in form and brightness; an inference which, however, seems to have had no foundation, except in the inadequacy of the instruments then in use. It stands No. 31 in the catalogue of Messier, communicated to the Academy of Sciences in 1771. Sir W. Herschel estimated its dimensions at about $1\frac{1}{2}^{\circ}$ in length by upwards of 16′ in breadth, and considered it undoubtedly the nearest of all the great nebulæ. His illustrious son in 1826 described it as "very bright and of great magnitude, and altogether a most magnificent object," its brilliancy increasing gradually from the edges to the centres where he found a kind of indistinct nucleus of stronger light, about 10″ or 12″ in diameter. Lamont observing it ten year, afterwards at Munich, with a power of 1200 on a very large achromatic, gave this magnitude about 7″. On the mounting of the great achromatic by Merz, of $14\frac{3}{4}$ inches aperture and 23 feet focal length, at the Cambridge Observatory, Harvard College, U.S., in 1847, nothing was remarked at first but a vast number of stars of various magnitudes scattered over its surface, an almost star-like nucleus, and a sudden termination of the light all along the *n p* side. But it was subsequently perceived that this abrupt bordering was occasioned by the presence of a long dark streak, $1\frac{1}{2}'$ broad, beyond which the hazy light recommenced, though with less intensity, for about 4′, when it was a second time interrupted by a similar dark band, and again continued till it faded entirely away. Thus one side of the great mass appeared subdivided lengthways by two dark canals, the innermost nearly 1° in length, straight for half that distance, but subsequently bent a little inwards; the other not so extended in length, and inclined to the first at an angle of about 3°. A truly wonderful structure is thus indicated, but, as it would seem, not without a parallel in the heavens, many other instances of arrangements more or less analogous having been pointed out by Sir J. Herschel and the Earl of Rosse; and unless, as the former has suggested, we can conceive the interposition of imperfectly transparent matter nearer to our eyes (which seems very difficult), we must suppose it to be a kind of stratification of the nebulosity presented edgeways to our sight, and giving us but little opportunity of conjecturing what might be the aspect of the luminous mass viewed in a transverse direction. The Earl of Rosse, indeed, seems to incline to the opinion that there may be an extreme fore-shortening of some kind of annular formation, the dark streak being the perspective projection of an interior void; but he has not referred to the complication introduced by the presence of the second streak, which would seem to require a kind of figure-of-eight arrangement; and,

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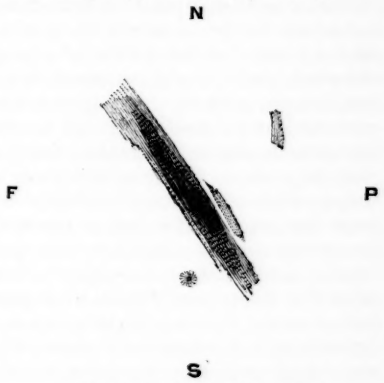
with the modesty characteristic of a true philosopher, he admits that his explanation is not very satisfactory.

As might be expected, these canals are very difficult telescopic objects, and perfectly hopeless with small apertures. I should never have thought of looking for them but for Secchi's valuable piece of information, that the first or innermost canal is the apparent exterior boundary of the nebula in small instruments, as well as his statement that the $6\frac{1}{3}$ inches of the Cauchoix achromatic at Rome were sufficient to show the first, with as much of the nebula beyond it as reaches to the second canal. Thus instructed, I attacked the object, a good while ago, with my $5\frac{1}{2}$ inches, but so entirely without success that I never repeated the attempt till the memorable night of the earthquake, when, the atmosphere being clear, notwithstanding rather *flaring* definition, I detected, with a comet eye-piece, power about 29, as well as with a higher power of 64, the lighter tract between the two canals, like a riband of the thinnest gauze drawn over the dark sky, parallel for some distance to the edge of the main body of light, but separated from it by the innermost of these open spaces. Faint as the object was, even as a mere suspicion, and utterly undiscoverable except from previous knowledge, to my great pleasure it was unquestionably there. I then perceived at once the inaccuracy of the expression that Bond had discovered these canals *in* the nebula, unless it were at the same time stated that he had given to it a previously unsuspected extent,—what he calls the *axis* of the nebula being nearly the whole of it as visible in inferior instruments,—and that these features were to be sought outside of the nebula as commonly seen, in the newly detected part. I became aware at the same time but too plainly with how much justice Secchi has criticised Bond's figure, as giving too much strength to the light between and outside of the canals; a remark made also by the Earl of Rosse's assistant with the 3-feet reflector; in fact the engraving does not correspond with the attendant description, that "the light between them is two-thirds as bright as it is on the inner side of that which is nearest to the nucleus," since it has been made to appear sensibly equal. In my telescope the difference is extreme; the aperture being only just sufficient to make the feeble ray perceptible, at least to vision such as mine.

In other respects, too, Bond's figure is unsatisfactory, the proportional light of the two companion nebulæ being far from accurately given; its defects, however, have been greatly exaggerated in some of the copies, and that given by Arago, if it is to be considered as a copy at all, bears so little resemblance either to the original or to nature that, without a name, it

would be difficult to identify it. The accompanying diagram has no pretension to be considered as a picture, having been sketched subsequently from memory; it is merely intended as a guide to those whose telescopes have light sufficient to warrant an attempt upon the canals. The great nebula lies, as will be at once seen, between two other hazy objects, making the general effect still more remarkable. The one, small, round, and bright (*extremely bright; pretty large;* 30″ *or* 40″ *in diameter*; with Sir J. Herschel's 18-inch speculum), was discovered in November, 1749, by Le Gentil, and is known as M(essier) 32, or H(erschel, jun.) 51 (*h* 51, in the unassuming notation of that eminent observer). It lies nearly *s* of the nucleus, at a distance of 26′. The Earl of Rosse expresses little doubt of its resolvability, as to which Bond offers no opinion. The other, 18 H V, *alias* H 44, was discovered by Miss Carolina Herschel, August 27, 1783; it is about 40′ distant from the nucleus in a *n p* direction, but may be brought, with a low power, into the same field with the great nebula, to which its faintness offers an interesting contrast. I have thus seen it well with $3\frac{7}{10}$ inches of aperture. Smyth says that it lies between two sets of stars of four each, each resembling the figure 7, the *p* group being the smaller. Herschel I. gave its dimensions 30′ × 12′; his son, who calls it *pretty bright*, about half that size (but in moonlight). Bond states that it appears, under high powers, to be a coarse cluster of stars. The nature of the great nebula, however, is less certain than that of its companions, and notwithstanding all the pains that have been taken to ascertain it, it has continued sufficiently mysterious. Smyth indeed states that the 3-foot speculum of the Earl of Rosse showed stellar symptoms at its edge; but we have heard of no confirmation of this with the fourfold light of the larger reflector. De Vico and his colleagues *thought* they resolved the nucleus in 1841, with 824 of the Cauchoix achromatic, and Secchi had the same impression in some very clear evenings. But this seems very improbable, when Herschel II. states—in a far inferior climate it is true, but



THE GREAT NEBULA IN ANDROMEDA.

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with 18 inches of reflecting aperture—that its nebulosity is of the most perfectly milky irresolvable kind, without the slightest tendency to that separation into flocculi which he perceives in the nebula in Orion, nor is there any sort of appearance of the smallest star in the centre of the nucleus. Secchi himself, afterwards, with the far superior Merz telescope, whose admirable definition gives it, he thinks, more resolving power than even the Rosse reflector, though he perceives five or six points in the nucleus, admits that they are not sharp enough for stars, comparing them rather to the granulations seen in the heart of some comets; and since he finds the surrounding fields for a great distance equally rich in minute stars with those in which the nebula occurs, concludes that the nebula is not resolvable, *si non peut-être dans son centre*. Bond, employing more than twice the light, says, "with high powers, minute stars are discerned on the borders of the nucleus, but it has thus far yielded no evidence of resolution; about 50 stars are visible in the same field with it; no other equal space occurs within the limits of the nebula, containing so few;" and while he estimates that above 1500 stars are visible with the full aperture within those limits, he asserts that they have "the undefinable, but still convincing aspect of not being its components."* It is certainly a singular fact that the two most remarkable nebulæ in the heavens, in point of combined extent and brightness, this, and that in Orion, should be alike characterized by their peculiar difficulty of resolution. Sir J. Herschel has indeed stated that such is the general character of all elliptic as opposed to globular nebulæ; and to this class (though Secchi dissents, giving it a dove-tail or triangular form) our present specimen is usually referred; but we are not brought thus one step nearer to an explanation of the difficulty. If, guided by its brightness and dimensions, we assign to it, with Herschel I., a position of comparative nearness, then its difficulty of resolution, as far as the centre is concerned, might be accounted for upon the supposition of a most extraordinary compactness of aggregation, but this would not explain the "milky" character of its fainter parts, which ought, as in many other nebulæ, to exhibit their components, though the central condensation may remain an impenetrable "blaze." If, on the contrary, we prefer looking upon its intractable character as an argument of exceeding remoteness, we must accept an overpowering result both as to dimensions and splendour. In Bond's telescope its light is diffused through an area $2\frac{1}{4}'$ long and nearly $1\frac{1}{4}'$ broad, not far short

* Bond's expressions must have been somehow misunderstood by the usually accurate Humboldt, who asserts, in three places, that he actually accomplished the resolution, and considers it one of the most remarkable discoveries of the time. Sir J. Herschel, too, on the same authority, speaks of the "decisive evidence" of its resolvability.

of 5 full moons by 3; so as to involve, whether really or only apparently, the two companion nebulæ; and what conception can we form of a magnitude so vast as would be indicated by this outspreading of a mass of distant suns? or of a brilliancy so vivid as the central portion must possess, to impress itself from such remoteness upon the unaided eye? There is, indeed, no impossibility in either alternative; nothing is too great or too magnificent for Omnipotence; but still the question naturally presents itself, whether this glorious nebula is really composed of stars at all? The doubt is not obtruded upon us, as in the case of that in Orion, by well-grounded suspicions of change; but if the existence of luminous haze were once established in that or any other instance, we should naturally look to it as the easiest explanation of the present difficulty. The final solution must, however, be sought in Orion, not here, where the gradations of light are less sudden, the features less marked, and the stars less brilliant, and hitherto not identified or delineated. But, possibly, results as yet unlooked for may even here be in store for instruments such as the 18½-inch achromatic of Clark, the 20-inch of Buckingham, or the 25-inch on which Cooke is said to be at present engaged.

We shall next proceed to another nebula, in its general aspect very dissimilar to the last: —

4. *The Nebula in the Triangle.*—The little constellation so called, which is pretty well marked out by its stars, lies, in a general sense, between *γ Andromedæ* and *α Arietis*: its *lucida*, *α*, at the apex of the triangle, being however far advanced towards a line joining the latter star and *β Andromedæ*. Rather more than one-third of the distance along this line, reckoning from the upper end, we shall readily detect our object. It was discovered by Messier in 1764, and is designated as 33 M., or 131 H.; and Herschel II. sees it "enormously large, very gradually brighter in the middle," the diffused nebulosity extending 15′ *s*, and nearly as much *n* from the centre. It has, he observes, "irregularities of light, and even feeble subordinate nuclei and many small stars." His father's V. 17, he thinks probably part of it, and this portion, according to Smyth, was seen mottled by H with his 7-foot reflector in 1783, and afterwards resolved with larger telescopes into stars, "the merest points imaginable." The admiral describes it as large and distinct, but faint, followed by five stars, between which and the object there is an indistinct gleam of mere nebulous matter. The peculiarity of this nebula is its visibility even in very small instruments, combined with especial dimness under what might be supposed more favourable circumstances: thus I could detect it with the finder of my old achromatic, and saw it well with 64 upon its aperture of

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$3\frac{37}{10}$ inches, while with 144 it was not distinguishable: with my present finder of $1\frac{1}{12}$ inch aperture it is easily seen as a large faint cloud; it is a beautiful object, much resembling Smyth's description, with $5\frac{1}{2}$ inches and a comet eye-piece, power 29; with 64 the brighter part seems resolvable; but it will not bear 164. The reason of this peculiarity is simply its great extent, which catches the eye as a whole in the large field of a low power, even with a very small aperture, while, filling the whole field of higher powers with feeble nebulous light, it fails in that contrast with the dark sky which is required to make it fairly visible.

We will now turn to another contrast as great as can be well imagined.

5. 34 M. (248 H.) *Persei.* This will be found in the following manner. Reverting to *α Persei* (Intellectual Observer, vol. ii., 374) we must draw a line *s*, a little *p*, which will soon pass through a conspicuous star, usually little inferior to *α*; this is the well-known *variable*, one of the leaders of that wonderful class, *β Persei*, or *Algol*, which also stands where two lines from *α Persei* and *γ Andromedæ* meet at a right angle. Between *Algol* and *γ Andromedæ*, but nearer to the former, and a little *n* of the line joining them, the eye will catch a dim speck, a small nebula properly so called, which the finder will resolve into stars, and the telescope will spread out into a beautiful brilliant scattered group, requiring a low power to show it well, but then forming a truly magnificent field, including, as Smyth observes, several coarse pairs. H. sees here about twenty stars, from 9 to 11 mag., and as many more of a smaller size. Its discoverer was Messier, in 1764.

OCCULTATIONS.

These will be rather numerous during the present month, including one which may prove well worth attention. Dec. 19th, *π* Piscium, 6 mag., will disappear at 4h. 29m., and reappear at 5h. 13m. 23rd, *l* Tauri, $5\frac{1}{2}$ mag., will be hidden from 4h. 5m. till 4h. 52m. 24th, χ^4 Orionis, 5 mag., from 5h. 38m. for an hour:—unfortunately, near the time of full moon. 26th, 1 Cancri, 6 mag., will disappear at 12h. 38m., and reappear at 13h. 57m. 27th, A^1 Cancri, 6 mag., will be occulted from 11h. 35m. till 12h. 54m. 28th, *ω* Leonis, 6 mag., from 10h. 59m. till 12h. 13m. This being a very close double star, probably not more than 0″·75 apart (I do not know its present measurement) its occultation would prove of great interest, supposing that the position of the limb is not coincident with that of the stars, as, even with instruments that cannot divide the pair, their duplicity would be made evident by a break in the loss or recovery of light. In this instance, the disappearance unfortu-

nately takes place at the bright limb, and the observer's success will therefore depend upon the very uncertain contingency of his having the point of reappearance at the dark limb just under his eye. This may indeed be secured by a wire in the field with an equatoreal mounting; but it will demand very pertinacious watching, as the actual times, and the consequent amount of duration, will vary from those here given, in proportion to the distance of the station from Greenwich. 30th, 55 Leonis, 6 mag., will be hidden from 10h. 13m. to 10h. 31m.

ARITHMETICAL RECREATIONS.

THE following paper, communicated by M. Plateau to the Belgian Academy, is translated from *Cosmos*, and will not fail to interest a large circle of our readers by its exhibition of amusing and unexpected properties of numbers :—

M. Plateau states that a long while ago he heard the following recreative problem proposed :—Given as a multiplicand the curious number 12,345,679, it is required to find a multiplier which shall furnish a product entirely composed of a repetition of any one number, chosen at pleasure. If the figure required to be repeated in the product be 1, the multiplier required will be 9. If the repeated figure is 2, 3, 4, etc., the multiplier must be the product of 9 multiplied by such figure. Thus, to have a product consisting of 2 repeated in succession, the multiplier must be $9 \times 2 = 18$; and to obtain a repetition of *threes*, it must be $9 \times 3 = 27$, etc.

Mr. Plateau supplies the following general rule applied to this class of proposition, and he believes it to be his own discovery :—

Any unequal number being given as a multiplicand, provided it does not terminate in 5, it is always possible to find another number as a multiplier which shall give, with the former, a product composed entirely of the iteration of any figure that may be named.

To do this, divide unity by the number given as a multiplicand, which will give a periodic decimal fraction, in which the period will commence immediately after the point, it being understood that the ciphers preceding the significant figures belong to the period.

If the number given be not divisible by 3, the period will be divisible by 9; make this division, and the quotient will be the factor sought, taken singly, or multiplied by 2, 3, 4, according as the product is required to be composed of *ones*, *twos*, *threes*, *fours*, etc. If the number given be divisible by

3, and not by 9, the period may not be divisible by 9, but it may be by 3, and in this case divide the whole of the three periods by 9, and the quotient will be the factor sought.

Lastly, if the number given be divisible neither by 9 nor by 3, divide by 9 the whole of 9 periods, and the quotient will be the factor sought.

If, for example, N be the number given—subject to the condition of its being uneven, and not terminated by 5—and we convert $\frac{1}{N}$ into a periodic fraction, and if we represent the period by P, we shall have

$$\frac{1}{N} = \frac{P}{999\ldots.}$$ from whence we obtain $999\ldots. = P\,N$.

If the number N is not divisible by 9, the period P will be so. In this case let us call Q the quotient of $P \times 9$, and we shall have $111\ldots.. = 2\,N$, and we shall find the factor which is sought.

As for the case in which N is a multiple of 3 or of 9, and in which P may consequently be divisible by 9, it is plain that we have only to take, instead of P, the reunion of three or nine periods, so that the whole may be divisible by 9. For example: suppose the number given be 7, we find $\frac{1}{7} = 0{,}142{,}857,\ 142{,}857\ldots..$; the factor sought will be $\frac{142{,}857}{9} = 15{,}873$; and, in fact, 15,873 multiplied by 7, gives 111,111; and twice 15,873, or 31,746, multiplied by 7, gives 222,222, etc.

If the number given be 3, we have $\frac{1}{3} = 0{,}3333\ldots..$; and the period is divisible by 3, but not by 9, we therefore divide by the reunion of three periods—that is to say, 333, and the quotient 37 will be the factor required.

If 27 be the number given, the period will be 037, which is neither divisible by 9 nor 3, and consequently we must take the reunion of nine of these periods to divide by 9, which gives the number 411,522, 633,744, 855,967, 0,781,893.

We see by this last example that for a small number given as multiplicand, we may require a very high multiplier; but, on the other hand, a high multiplicand may require a small multiplier, as, if the great number just recited had been that given as a multiplicand, we should have found 27 as the multiplier.

THE GENUS FISSIDENS; OR, THE FLAT FORK-MOSSES.

BY M. G. CAMPBELL.

THE Fissidentes, like their toothed allies which we considered last month, are perennial plants, and grow on the ground, or on rocks, but rarely on the bark of trees. Their foliage, however, bears no resemblance to that of the Dicranums, being, instead of setaceous and secund, flattened, the upper part expanded into a vertical scalpelliform lamina, and inserted in two opposite rows alternately on the opposite sides of the stem, or *rachis;* for this arrangement gives a frond-like appearance to the stem.

Indeed, the peculiar and highly curious structure and disposition of the leaves of this genus very naturally separate it from all other British mosses with which we have any acquaintance, while the insertion of the fruit seems to make it a connecting link between the *Acrocarpous* and *Pleurocarpous* sections; the capsule in some species being terminal, in others lateral, arising from a short fertile ramulus, to which arrangement Wilson gives the term *Cladocarpous*.

The singular structure of the leaves, besides their being vertical, consists in an expansion of tissue from the nerve, and a prolongation of one of the wings of the true leaf, making the leaf, on the stem side, double from above the middle to the base, the expanding wing clasping the stem. This is more conspicuous in the upper leaves, the length of the wing gradually diminishing, and the lower being almost destitute of this strange appendage.

The author above named enumerates and describes in his valuable *Bryologia Britannica* eight species of Fissidens, most of which may be found in fruit during this month. They derive their generic name from the Latin fissus, *split*, and dens, *a tooth*.

Among the most common is *Fissidens taxifolius*, or the yew-leaved flat fork-moss. It inhabits moist, shady banks, chiefly in a clayey soil. The inflorescence is monoicous; the gemmiform barren flower sitting at the base of the fertile stem. The stems are branched, and fasciculate, *i.e.*, with short lateral branches of unequal height; the taller in this instance are about half an inch long; they are clustered several together from a common rooting base, where both barren and fertile flowers originate. The leaves are crowded, lanceolate, apiculate, very minutely crenulate, of a light green, not twisted

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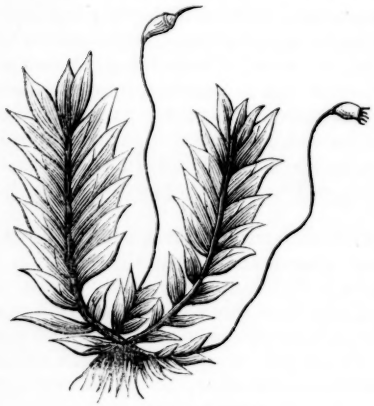
when dry, and with a pellucid nerve extending almost to the apex, the dorsal wing broad to the base, but not decurrent. As in the rest of the genus, they are *equitant, i.e.*, inserted in two ranks, the leaves of each rank partly sheathing each other at the base of the leaf.

The seta arises from near the root to about, or rather more than half an inch in height, is flexuose, curved at the top, and its perichetial leaves are pointed, convolute, ovate, and sheathing; the capsule is oblong, or obovate, inclined or horizontal, of thick texture, constricted below the mouth when dry, reddish brown; the lid convex at the base, with a beak nearly as long as the capsule; the calyptra whitish, rather longer than the lid, and dimidiate, or splitting along one side. The oblong vaginula is distinct, and not insensibly passing into the perichetial ramulus as in truly pleurocarpous mosses.



FISSIDENS TAXIFOLIUS.

The illustration given is, of course, considerably magnified.

Another example of the cladocarps, and looking at first sight much more like a pleurocarp, is *Fissidens adiantoides*, or the marsh flat fork-moss, the smaller forms of which somewhat resemble *F. taxifolius*, from which however it is clearly distinguished by the position of the fruit stalk, which is lateral at a considerable distance from the base of the main stem, which latter is elongated and branched, with crowded, ovate, lanceolate leaves, denticulate at the apex, minutely serrulate below, and nerved to the point. In moist situations the stem reaches more than two inches in length, with dark green leaves and sub-fasciculate branches, more loosely cæspitose; in dryer situations it is shorter and more densely tufted. The leaves are crisped and incurved when dry. The fruit stalks rise from about the middle of the stem to from half an inch to an inch in length. The capsule is more or less inclined, of thick texture, constricted below the mouth, and somewhat turbinate when dry. The lid with a long beak, and the calyptra still longer. Its favourite habitats are shady banks, wet pastures and bogs, and on wet rocks near waterfalls.

We have found it in great abundance on a rock just above Longfords Lake, under the shade of trees in Gatcombe Wood, Gloucestershire.

As an example of the terminal-fruited section, we may instance the common flat fork-moss, *Fissidens bryoides*, to be met with almost everywhere, even in the sandy deserts of Africa, where its exquisite beauty and wondrous structure spoke so eloquently to the heart of the renowned traveller, Mungo Park, at a time when, worn with fatigue, plundered by banditti, and surrounded by all the horrors of the desert, his sinking courage had well-nigh failed, and he threw himself down to rest his weary limbs and ponder on his destitute condition. He says himself, after describing his state—"At this moment, painful as my reflections were, the extraordinary beauty of a small moss irresistibly caught my eye; and though the whole plant was not larger than the tip of one of my fingers, I could not contemplate the delicate conformation of the roots, leaves, etc., without admiration. Can that Being, I thought, who planted, watered, and brought to perfection, in this obscure part of the world, a thing of so small importance, look with unconcern upon the situation and sufferings of creatures formed after his own image? Surely not! Reflections such as these would not allow me to despair. I started up, and disregarding both hunger and fatigue, travelled forwards, assured that relief was at hand, and I was not disappointed."

Such is Mungo Park's own account of the incident, and from original specimens of the moss given by his brother-in-law, Mr. Dickson, to our celebrated botanist Hooker, the latter was able to ascertain the species as *Fissidens bryoides*, which we will now proceed briefly to describe. The general structure and arrangement of its leaves sufficiently characterize the family group to which it belongs, but it is smaller than either of those already noticed, the stems rarely averaging more than from two lines to half an inch long. The barren flowers are numerous, gemmiform and axillary, never terminal, which the fertile flower is, producing a symmetrical capsule on a red seta, and having a red peristome with a persistent rudimentary annulus and a rostellate lid. The leaves are spreading, widely lanceolate, apiculate, and with a thick cartilaginous border. It is met with in fructification at various seasons, but particularly in the winter months, December, January, and February, and its exquisite beauty cannot fail to strike with admiration any one who will bestow upon it an attentive examination. All the family, in common with the Dicranums, possess sixteen bifid teeth. For a description of the latter, see the INTELLECTUAL OBSERVER for November.

The remaining members of the group are *F. exilis*, slender

flat fork-moss; *F. viridulus*, green flat fork-moss; *F. osmundoides*, Alpine flat fork-moss; *F. asplenoides*, fern-like flat fork-moss; these all having terminal fructification; and *F. tamarindifolius*, short-leaved flat fork-moss, with an axillary cladocarpous fructification.

THE PHILOSOPHY OF EARTHQUAKES.*

In our last number we collated the principal facts connected with the British earthquake of October, 1863, and made a few observations, preliminary to a more particular study of this class of convulsions. Let us, in resuming the inquiry, first endeavour to form some conception of the earth, or rather of its crust, or outer portion, as a *whole*. We must not figure it as a quiescent body, which would be far from the truth, but regard it as undergoing incessant change, under the action of forces operating in different directions, and producing contrasted effects. For two thousand years astronomers know that our globe has made no change in its diameter sufficient to produce any recognizable effect, and it may have been equally still in this respect through time-periods of inconceivable extent. Yet we cannot imagine that at any time its various formations were absolutely at rest. On the surface, rivers are constantly carrying down to the sea myriads of tons of solid matter taken from adjacent lands; atmospheric influences disintegrate and crumble various rocks, and other agencies constantly take to pieces the structure that exists. On the other hand fresh strata and fresh structures are being formed, with equal continuity of operation, and if one set of forces tend to pull down and level, another set of forces produce upheavals and diversities of height.

Sir Charles Lyell gives a beautiful illustration of this action and counter action of forces, when he instances the case of a large river bringing down sediment which gradually fills up a sea hollow 2000 feet deep. If elevation then takes place to the extent of 2000 feet, we shall have a mountain of that height; but if our sea bed had been raised before the 2000 feet of river sediment had been deposited, instead of a mountain we should only have had a shoal. Thus, when earthquakes are

* *The First Principles of Observational Seismology*, as Developed in the Report to the Royal Society of London of the Expedition made by command of the Society into the interior of the Kingdom of Naples to investigate the circumstances of the great Earthquake of December, 1857, by Robert Mallet, C.E., F.R.S., F.G.S., M.R.I.A., etc., etc. Two vols. *Chapman & Hall.*

British Association Earthquake Catalogue. Taylor & Francis.

connected with movements of elevation, their operations are often such as to cause the levelling power of water to counteract itself; and although the idea may appear paradoxical, we may be sure whenever we find hills and mountains composed of stratified deposits, that such inequalities of the surface would have had no existence if water, at some former period, had not been labouring to reduce the earth's surface to one level.* It does not, however, follow that the *average* action of earthquakes is one of elevation, although they are plainly connected with movements that often have that effect. When there are great hollows resulting from the outpouring of subterranean matter by volcanoes and mineral springs, or from the solidification of enormous masses of rock, severe shakings must tend to convey matter from the surface towards the interior of such hollows, and in such cases earthquakes will exert a depressing effect. It is obvious that if actions of degradation went on for long periods unchecked, the earth would become an uninhabitable flat, while if the opposite movements of elevation were not counteracted for an equally long period, the mean diameter of the globe would increase, and the surface would become like a huge irregular bubble, destined ultimately to sudden and disastrous collapse. The existence of the animals and vegetables that inhabit our globe is strictly, though by no means exclusively, dependent upon the class of forces to which earthquakes belong, and therefore Sir C. Lyell is justified in affirming that "they are agents of a conservative principle, above all others essential to the stability of the system."

The earth's permanence is the result of forces, every one of which is engaged in destroying a previous condition of things, and introducing a new one; but which are so antagonised and balanced as to leave it substantially the same. We need not now speculate on those residues of unbalanced forces which may ultimately change it altogether, as their operation is infinitesimally slow, and can only become sensible after the lapse of time-periods utterly beyond our grasp. They also belong to the *cosmos* as a whole, and not specially to our minute speck of it; and if our sun, with all his attendant worlds, should ultimately pass into another form, it would no doubt be in obedience to laws as conservative of the entire universe as earthquake laws are conservative of our terrestrial sphere.

If the reader has followed this argument, he will be prepared to deal with earthquakes as phenomena of order, and to learn that the exact calculations of the mathematician are found applicable to them, so far as their conditions can be made out. He will also be prepared to discriminate between actual shocks or concussions, and the tumbling in, or slipping down

* *Principles of Geology*, 9th edition, p. 564.

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of unsupported strata, which may take place in consequence of an earthquake, or may occur without its aid.

If we look at the Seismographic ("Quake-descriptive") map of the world, drawn by Messrs. Robert and William Mallet, and published in the *British Association Catalogue*, we see some connection between the principal lines of earthquake action—and the great mountain chains. We likewise see that our islands—although not far from Iceland, in which such action is violent, or from Southern Italy, in which it produces very serious effects—lie in a region of comparative calm, which is not likely to be exchanged for one of earthquake storm, except by the very slow operation of causes, which would alter the physical geography of our portion of the globe.

Hereafter, when men know better how to guard against the perils of earthquakes, highly industrious and civilized communities may live in regions subject to severe shocks; but the chief seats of progressive races have hitherto been in places tolerably secure. But, notwithstanding their dangerous character, when shocks are frequent, people get so used to them, that Humboldt tells us of districts in South America "in which the inhabitants take no more notice of the number of earthquakes than we in Europe of that of showers of rain," and where, he adds, Bonpland and himself were compelled to dismount on account of the restiveness of their mules, "because the earth shook in a forest for fifteen to eighteen minutes without interruption." Of such localities Sir C. Lyell well observes, that "where earthquakes are frequent, there never can be perfect security of property under the best government; industry cannot be assured of reaping the reward of its labour, and the most daring acts of outrage may be perpetrated with impunity when the arm of the law is paralyzed by general consternation. It is hardly necessary to add that the progress of civilization and national wealth must be retarded by convulsions, which level cities to the ground, destroy harbours, make roads impassable, and cause the most cultivated valley plains to be covered with lakes, or the ruins of adjoining hills."

The bands of seismic influence "very generally follow the lines of elevation which mark and divide the great oceanic or terr-oceanic basins (saucers) of the earth's surface. And, in so far as these are frequently the lines of mountain chains, and these latter those of volcanic vents, so the seismic bands are found to follow them likewise." Thus says the *British Association Catalogue*, and it adds, that "the surfaces of minimum, or of no known disturbance, are the central areas of great oceanic or terr-oceanic basins, or saucers, and the greater islands existing in shallow seas." The Ganges and Mississippi river basins, as explained, do not conflict with this last proposition, as when

the mountain ridges "are very large in relation to the basin, the breadth of the seismic band may overlap the whole surface."

If, from these general considerations we proceed to study the particular phenomena of earthquakes, we find that the fundamental propositions laid down in Mr. Mallet's *Seismology* are, that "the elastic wave or earth shock may reach a given point upon the surface with any angle of emergence (the angle contained by the horizontal plane with the wave path at the point of emergence), or in any azimuth. The path of the wave is a right line, joining that point with the centre of impulse (or focus), the wave being assumed to be propagated from thence in all directions in spherical shells. This is strictly true only in a homogeneous elastic solid." We dare say this will appear very unintelligible to persons unaccustomed to such considerations; but it will soon become plain. Draw a large circle on a sheet of paper, and let this represent a solid globe. Then draw a small circle in the middle of it, and let this represent a hollow place. Then imagine a little gunpowder ignited in the centre of the hollow. Its explosion would strike the walls of the hollow equally in all directions. Suppose the walls elastic, and too strong for the explosion to break; they would still experience a shake all round, and they would in turn shake the neighbouring particles all round, and these again another set, and so on, producing concussion waves, one outside the other, and forming what Mr. Mallet calls "spherical shells." Thus a number of circles drawn outside the circle bounding the hollow would represent these "shells," and, if continued long enough, they would extend to the large outer circle of all. Draw a horizontal line, touching this circle, and then, from the same centre as all the former circles, draw a great circle cutting the horizontal line, and this will represent the concussion wave emerging at the surface of the earth.

Such a diagram, made without any difficulty, will explain to the eye how concussion waves, starting in all directions from a point below the earth's surface, widen and widen their circles, until they reach that surface.

The next essential thing is to learn what is meant by the "seismic vertical," and we perceive its nature if we draw a line from the centre of the hollow, or point from which the concussion proceeded, up to the horizontal line representing the earth's surface, and falling *perpendicularly* upon it. To obtain another illustration of this matter, give the under side of a table a tap with a small hammer; whatever is placed exactly above the hammer on the table, so that the concussion would throw it straight up in the air, is in the seismic vertical, and

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if the shock communicated is not very violent, and the object not top-heavy, it will not be overthrown, but simply raised, to fall back where it was before. But any hammer stroke will have given a concussion to the whole table—one concussion wave after another will spread, like those produced by throwing a stone in a pond—and they will reach the surface and emerge further and further off the centre of the shock and the seismic vertical, each one coming out more slantingly than that which preceded it. Thus we might draw on the surface of the table concentric circles, each representing the crest of a concussion wave, the waves growing weaker and weaker as they extend further and further from the original point of shock. Every circle thus traced would represent a line of equal shock, or, in technical terms, a *co-seismal line;* that is to say, a line on which objects would be equally shaken on whatever part of it they might happen to be placed.

Having thus formed an idea of lines of *equal shock,* we must consider the line of *maximum shock,* or, rather, maximum power of overthrowing objects. A body like a sugar-loaf, or a skittle, would not be readily overthrown by striking the table immediately under it. The blow might be severe, but its direction would make it feeble in *overthrowing power,* while a concussion that reached the skittle more obliquely, though of less violence, might be quite sufficient to throw it down. We have seen that the greater the horizontal distance from the seismic vertical at which a concussion wave emerges, the greater its slant. Now, the most advantageous mode of exerting force to upset a skittle is to give it a shove *horizontally,* and above its centre of gravity; and thus the concussion wave improves the *direction* of its force as an upsetting power by slanting from the seismic vertical; but as it slants it gets further off its origin or source—its energy is spread over a greater area, and is weakened in consequence. There will, however, be a certain distance from the seismic vertical at which loss of power will be compensated by gain in direction, and a line connecting *all* such points will be the line of maximum overthrow, or *meizoseismic line.* In our illustrative diagram this may be a circle, but in nature some of our supposed conditions never occur. In real earthquakes the focus from which the disturbance proceeds will not be a point, but an irregular, and often very large space, and the surrounding earth strata will be of different structure and density, better able to transmit a shock in one direction than another. Thus we shall not find the co-seismal lines (in nature) making circular curves; but, although less regular and more difficult to trace, they will still be distinguishable when the circumstances are favourable.

To prevent a misconception, we must now advert to a fact

we omitted for simplification in our directions for diagram drawing. What is called in mechanics the *vis viva* of the concussion wave "must remain constant, and (in the same medium, its dimensions being very great) the velocity of translation also. The *mass* in wave movement, at any moment of its transit, is therefore the same, and the thickness of each successive spherical shell decreases from the centre of impulse as the square of its mean distance."* We should therefore have to make our circles less and less in the proportion specified, in order to have our diagram correct.

A very important fact to be remembered is thus stated by Mr. Mallet in his great work, when he tells us that "the distinction must be clearly borne in mind between the velocity of transit of the wave, that with which the advancing *form*, or seismal curve, is transferred from point to point of the surface, and that of the earth particles moving within the limits of the amplitude of each vibration." This will be plain enough to most of our readers, but for others whom it may perplex, it may be stated that when an elastic body is thrown into wave motion, the *force* that compels that motion travels from particle to particle *faster* than the particles themselves move. In earthquake waves, Mr. Mallet considers the velocity of the former to equal half the speed of a cannon ball, while the latter, he tells us, "is often not greater than that which a body acquires by falling from a height of two or three feet." Thus the quake will visit various localities in succession immensely quicker than it causes any body to move; were it otherwise, the stones of a building overthrown would be hurled about like cannon balls, and, weight for weight, be as destructive as they are when half their commencing velocity has been lost.

When an earthquake reaches a building, or any object whose dimensions are less than its own amplitude (or width), its first proceeding is to impart to it a motion that tends to carry the base *forward*, and thus, if the object be overthrown, it falls *backward*, if free to fall in any direction. If we knew that an earthquake was likely to come, we might arrange two rows of wooden cylinders, all of the same height, but varying in breadth, from the first in each row, broad enough to stand very firmly, to the last in each row, so slender as to be easily overthrown. If these two rows stood upon two boards at right angles to each other (as represented in the diagram, p. 98, *British Association Catalogue*) no shock could reach the earth's surface at that place without affecting them, and one set would be in such a position as to be able to fall freely *across the plank*, without touching each other, provided they were far enough apart. Suppose a bed of sand arranged for the cylinders

* *British Association Catalogue*, p. 111.

to fall in and stop their rolling, their overthrow would then give us much information.

First, we should get to know the force of the shock, because it either knocked down all, and thus was competent, or more than competent, to the hardest work we had set it, namely, to overthrow the cylinder of the broadest base; or it would knock down some, and leave others, and then we could say that it was able to upset cylinders not exceeding a known power of resistance. In the next place, we could tell the direction of the shock from that in which the cylinders fell. Now, excepting that these cylinders could not, like walls, be cracked by a concussion not sufficient to overthrow them, they would resemble, more or less, the buildings in a town, of course making allowance for difference of shape. If therefore we examine a town that has been damaged or destroyed by an earthquake, we ought to be able to learn from it what the cylinders taught, together with some other facts they could not show.

Hitherto, for the sake of simplification, we have omitted to speak definitely of the *opposite* motions of a concussion wave, which might without explanation be supposed capable of imparting movement in one direction only. The following extract from Mr. Mallet will place the composite action in a clear light. He tells us that, "as the co-seismal curve (or crest of a wave-shock) enlarges its area, travelling outwards in all directions from the seismic vertical—that is, from the vertical line passing through the earth's surface (and centre) and the focus—every point in and upon the surface, in succession, moves *once forward and back* in the direction of the wave-path, and to the extent of its amplitude at that point, or in two components, vertical and horizontal, that shall give such direction." An object may be overthrown by either the backward or the forward motion, and when the concussion wave emerges in a slant, the form of the body and its mode of standing, or being supported, will determine whether the forward or the backward motion is most dangerous to it.

When an earthquake makes an onslaught upon a town, tall, old, badly-built edifices may be reduced to a heap of ruins, while stronger buildings escape with slighter injury. In narrow streets of weak houses, a smart shock throws some down first, and they in falling tumble against neighbouring structures, and reduce the abodes of thousands to a pell-mell heap of rubbish, from which little more than the magnitude of the calamity can be learnt. When the buildings are stronger, and less affected by the disasters that happen to adjacent edifices, the work of devastation is more methodical, and frequently goes no further than the production of cracks, or fissures, indi-

cating that a measurable quantity of masonry has been moved in one or more given directions.

Such cracks are invaluable to the seismologist, and if he can find enough of them, he interprets their silent language into a veritable history of the shock. By the direction of the cracks he learns which way the concussion came; by the quantity of displacement work done he estimates its force, and from a sufficient collection of details he draws his curved lines of *meizoseismal* or greatest overthrow, and *isoseismal* or equal overthrow. A few points on a co-seismal line will also enable him to determine the seismic vertical, or the line perpendicularly over the focus of the disturbance. For reasons already explained, none of the isoseismal lines will be circles, nor will the focus of concussion appear as a single point. If, however, we may judge from the success with which Mr. Mallet investigated the Neapolitan earthquake of 1857, the practical application of seismological principles is easier than might be supposed, and bids fair, when extended to a sufficient number of concussions, to throw a valuable light upon these commotions in the crust of our globe.

We cannot attempt to indicate all the important questions discussed with great ability in Mr. Mallet's work, but we will endeavour to supply a sufficient quantity of elementary material to assist those who might, without such aid, find the work itself somewhat beyond their grasp, and to afford to others, who do not desire to fathom the subject, as much information as they will need. We must, however, recommend all to consult the book for themselves, because those who do not desire to *study* it will gain a great deal by reading portions and carefully examining the large number of beautiful and instructive plates. Proceeding with our necessarily imperfect sketch, let us inquire into the velocity of earthquake shocks. Mr. Mallet informs us that "the power of the wave-shock to produce overthrow depends upon the intensity of the wave, that is upon its amplitude, and upon the elasticity of the medium in its passing through, conjointly; and as all free displaced bodies must be displaced to the extent due to the greatest velocity impressed at the centre of gravity, the measure of such displacement is always that of the velocity of the wave particle at its maximum." In the endeavour to determine these velocities, Mr. Mallet found the cases divided into three groups: the first, in which the true wave velocity and its result were not much interfered with by surface oscillations; the second, in which the *velocity ascertained* "was made up of the true wave velocity plus that of the elastic oscillation of the surface at the displacing point," and thus was greater than the

true wave velocity; and thirdly, when from some cause the determination was below the truth.

The mean velocity of ten determinations was found to be 12·039 feet per second, of which the highest was experienced by a vase projected from a gate of the prince's garden at Certosa. This exceeded twenty-one feet, "but at least eight feet per second was due to the elastic oscillation at the top of the pier itself." A little hill, *colline*, at Saponara, appears to have had a velocity of oscillation = 1·724 per second. These low velocities did not coincide with preconceived ideas; but Mr. Mallet observes, that we are by no means to consider twelve or thirteen feet per second as the greatest possible velocity of an earthquake shock, as when the town of Riobamba was totally destroyed, Humboldt informs us that the bodies of many of the inhabitants were thrown upon the hill of La Calla, which rises to the height of several hundred feet at the other side of the Lican torrent. "The actual range of vertical projection of these bodies has been estimated at 100 feet. The velocity due to this height of projection is $V = \sqrt{2g}\,H = 80$ feet per second; and this is probably the greatest velocity of shock recorded, or perhaps at present possible upon our earth; it is nearly as great as that with which the body of one who should leap from the top of the Duke of York's column at London would strike the pavement; and taking the greatest *velocity* that we have ascertained for this (the Neapolitan earthquake) at fifteen feet per second, this maximum velocity is $\frac{80}{15}$, = 5·33 times greater than the velocity of our Neapolitan shock."

Bearing in mind the probable identity of the causes of earthquakes and volcanoes, it is evident that the height of volcanic cones should be proportioned to the earthquake intensity, and Mr. Mallet finds that the velocity of the Riobamba shock exceeds that of the Naples shock as much as the Andes are higher than Vesuvius.

If the focus of an earthquake was always at the same depth from the surface, the area of noticeable disturbance would be a measure of the force of the shock, but very violent concussions have been known to affect very limited spaces, and in such instances the foci must have been proportionably near the surface that was disturbed. "We may generally infer from this that earthquakes, like that of Lisbon, which have *a very great area* of sensible disturbance, have also a very deep *seismal focus*, and also that *the greatest depth of seismal focus within our planet is probably not greater than that ascertained for this Neapolitan earthquake, multiplied by the ratio that the Riobamba wave bears to that of its wave;* or, what is the same thing, by the ratio of the altitudes of the volcanoes of the

Andes to that of Vesuvius." This would give 30·64 geographical miles as probably the greatest depth of origin of any earthquake.

Here we must close our explanations, strongly advising our readers to have recourse to Mr. Mallet's elaborate and magnificent work.

We subjoin a few particulars relating to the late British shock, which reached us since the publication of our last number.

FURTHER NOTES ON THE EARTHQUAKE OF OCTOBER 6TH, 1863.

Since the publication of our last number, we have collected a few additional facts relating to the earthquake of October. In the first place, positive proof has been obtained that the wave-motion was sufficient to cause a noticeable displacement of materials. Thus, a correspondent, who sends us his card, and signs himself "A. L. S.," supplies the following interesting narration. He says:—

"SIR,—On receiving this month's INTELLECTUAL OBSERVER, I was very glad to find that it contained a record of the earthquake of October 6, the article being a careful digest of the chief reliable facts which have been published.

"You remark, p. 295, 'It is not unlikely that careful inquiries would lead to the discovery of fissures in old and weak buildings,' etc.; and with reference to this I select the following accounts from amongst a large number, and which, being definite and reliable, may be thought sufficiently interesting to your readers to merit a place amongst the 'Notes and Memoranda' next month.

"I have received and arranged 138 reports from 122 places; and so far as they show, it would appear that the shock was felt at and near the village of Garway—situated twelve miles from Ross, Herefordshire—with more severity than in any other locality. At this place, the house of Mr. Herbert suffered most; it is built of stone, has only a shallow foundation, and stands in a valley close to the river, nearly facing the cardinal points of the compass. The south wall was split from top to bottom, the direction of the crack being *from* east at the bottom. The crack has since increased, and the stone is loosened. The walls of all the top rooms were cracked, and one whole brick and three half bricks fell down a chimney into one of the rooms. At the house of Mr. Herbert, jun., in the same place, all the top room walls are cracked, also the ceilings, and a portion of one ceiling fell. The shock is described as uplifting and vibrating; the sensation, as if the bed were being lifted by its corners; and its violence was sufficient to throw a pair of candlesticks off a table. Domestic animals shared largely in the general terror, pigs shrieked violently, and eight farm-horses, which had been turned out for the night, galloped home.

"As tending to show the direction of the motion, the following

may also be useful:—In the lower part of the town of Ross, Herefordshire, the wife of a rev. gentleman was sitting up with an infant; she observed the west wall of the house perceptibly lean towards her, as if falling, and a chair was tilted off two legs in the same direction, nearly four inches. The large doors of a wardrobe, which were unfastened, were thrown open by the movement. The article stood back to the east, in the house of a medical doctor, also at Ross."

We are also indebted to the Rev. T. W. Webb for further particulars of occurrences in his district (Hay, South Wales), which show that the vertical component of the shock was strikingly exhibited. Thus, a man who was sleeping on an earthen floor in a valley of the Black Mountain, saw a board that was beside him struck up from the floor, and sundry three-legged tables and other heavy pieces of furniture were set "jigging," as the folks described it. A cottager's wife told Mr. Webb, that after the shaking of her bed in a room up one pair of stairs, and the "jigging" of a three-legged table at the foot of it had both *ceased*, she distinctly heard the chairs moved about in the ground-floor room underneath. In this case the first semi-phase of the vibration affected her room, and the second semi-phase operated more especially below. At same place in South Wales, the vertical component of the shock appears to have been strong enough to give a momentary *lift* to a gasometer, by which action gaslights were put out. At Cheltenham, the police were terrified by the clanking of the iron gates of the cemetery. Books were likewise thrown down from unfilled shelves, and pictures moved out of their proper positions, and left all awry. Mr. Webb also furnishes us with an extract from a Hereford paper, describing what occurred at Llandefailog Vach, about two miles north of Brecon. It states that at Glanhondda House a ceiling was cracked across, also one of the walls of Llandefailog House. The arch of one of the chancel windows in the church was forced apart some inches, the glass damaged, and a good deal of plaster torn off the wall. A ceiling was also cracked, and some tiles displaced, at Hereford.

It will be evident that if any person competent to apply the theorems of Mr. Mallet's book visited these localities, the probable depth of the focus of the shock might be ascertained.

In London and its neighbourhood a few remarkable things occurred. Thus, at the Greenwich Observatory, the Astronomer Royal states that one of his assistants, who was observing the collimation of the wires of the altazimuth, perceived the mark at which he was looking to move in an extraordinary manner, so that he thought the wall to which it was attached must be in motion. In Camden Crescent, N. W., a lady, whose hus-

band was out, was so convinced that some one was lifting up her bed, that she jumped out, and took refuge in another lady's apartment. Another lady, in the same locality, experienced a similar sensation in her bed; but she informs us that the china and glass articles on the wash-hand stand were quiet, although the passing of a railway train frequently makes them jingle.

Mr. Shirley Hibberd contributes the following letter:—

"My residence at Stoke Newington is on a clay soil, overlying a deep stratum of sand. It has recently, on the south side, been connected with a branch of the northern high level sewer. In the house are a few foreign birds, and amongst them a pair of Australian ground paroquets, which occupy a cage in a parlour on the south side of the house. My bed-room is on the north side, where all the brickwork of the foundation is in immediate contiguity with the clay, whereas on the other side the foundations comprise a considerable extent of cellarage and tunnelling. On the morning of the 6th of October I was sitting beside a cheerful fire in the bed-room, writing till some time after three a.m. I then turned down the lamp, and got into bed, and almost immediately got out again, and hurried down with the lamp in my hand to receive a supposed visitor, who appeared to have entered at a bound. Mrs. Hibberd was full awake at the time, and the impression she received from the disturbance was that a burglar had entered at the window of the parlour where the paroquets are kept; and, stepping on the edge of the table, had come down, table and all, with a crash. There has not been much said about the effect of the earthquake on animals, and I mention my birds in order to say that the alarm occasioned by the shock was sustained by the paroquets, which commenced screaming most vociferously, and as I never heard them before. The search for burglars required me to pass "Old Poll," who was awake and listening; "Trot," the cockatoo, who was ditto. I next passed my meteorological instruments, which I always look at from habit, under any and every circumstance, and I noticed that the barometer had not moved a hair's-breadth since last marked eighteen hours previously. I next encountered the screaming birds, expecting to find with them a grim human intruder. The poor birds were fluttering and screaming in a most painful manner, but a few kind words composed them, and once more we were quiet. The next occurrence was a repetition of the original shock in a very subdued manner—a sort of dull "thud;" then we noticed simultaneously that some large trees near the house were shedding their leaves, as if agitated by wind, though there was not a breath stirring. The time of these occurrences was between 3·20 and 3·30; the exact time was not noted, for the idea of burglars was so distinctly before our minds that our attention was almost wholly directed to discover whether we were really favoured with an inquisitive visitor. Had I suspected an earthquake, I might, being awake at the time, having a second witness at hand, having also a fire, light, time-piece, barometer, and other

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aids to observation within reach, have made some better use of the occurrence than I did; but who in these prosy times ever thinks of an earthquake till it is all over?"

The fact that some persons were strongly affected by the concussion, while others in adjacent houses did not notice it, need not surprise us when we take into consideration individual peculiarities of sensitiveness, occupation at the time, etc., etc., and also bear in mind the very different conducting power of hard and soft soils, and of various kinds of masonry. The beds or furniture in some houses would be in a more favourable line of disturbance than in others. In Mr. Hibberd's case the brickwork of the great drain may have conducted the shock to the foundations and walls of his house. A correspondent in the *Times* states that a strong shock occurred in Antigua at a period corresponding with 6th October, 2·28 a.m. English mean time. Further facts would be necessary to show whether this was a mere coincidence, or an indication of the range of the shock which these islands felt.

MOUNTING DRY OBJECTS.

BY T. W. WONFOR,

Hon. Sec. Brighton and Sussex Natural History Society.

We have received the following valuable letter from Mr. Wonfor. His method appears to be well worth trial, but great care must be taken in making the brass and glass surfaces quite clean. One of the cells he was kind enough to send loosened in transit. Probably attention to the surfaces and the use of marine glue would secure success:—

"Knowing the interest you take in all matters relating to the microscope, I have taken the liberty of addressing you upon a paragraph in this month's Intellectual Observer. The plan proposed by Mr. Ralf for dry mounting I tried some eighteen months since, and found it open to three objections. First, Heat does not perfectly unite the gutta-percha and glass; consequently a mere touch will remove the cell. Secondly, If there be the least moisture about the object, glass, or gutta-percha, it rises and dims the covering glass. Thirdly, Gutta-percha seems an admirable *nidus* for the production of microscopic fungi, as numerous slides spoilt by their growth testify.

"Gutta-percha cells, fastened with cement, are also liable to come off with a touch, and if employed must be painted inside with Brunswick black, etc.; by this means the growth of fungi is avoided. A cheap and more permanent form of cell can be made out of brass curtain-rings, which may be had from one-

quarter of an inch diameter upwards. They can either be flattened with a hammer, or rubbed flat on both sides on a stone, and fastened with 'liquid glue,' 'Bell's cement,' 'marine glue,' or any other cement used for fastening brass to glass. The rings cost from 8*d.* to 10*d.* a gross.

"If they are painted with Brunswick black afterwards, the brass is concealed, and they present the appearance of deep cement cells. The readiest plan I find is to prepare two or more dozen at a time; and as most opaque objects require a dark background, my punches, purchased for cutting gutta-percha, came in useful for cutting black patches.

"I send you a plain cell, one with cement and patch ready to receive an object, and another complete. For deeper cells I get a brass-turner to cut brass-tubing to the required depth. The same objection as regards fungi applies to the interior of ivory cells."

A NEW REVERSIBLE COMPRESSORIUM.

It is not long since we had occasion to notice a very excellent compressorium, devised and manufactured by Mr. Ross. It was worked by a single screw, afforded great facility for replacing the upper thin glass, and permitted the lower and thicker one to be removed, so that any object might be conveniently prepared upon it, under water if necessary. This compressorium, it seemed to us, might advantageously replace the live box, being quite as easily used, and very superior to it whenever delicacy of manipulation is required. But, notwithstanding the merits of this, and of certain other forms of the compressorium as constructed by other makers, there was still room for a new one, to meet requirements that are by no means uncommon in microscopic pursuits.

M. Quatrefage, by placing two brass pins upon the old lever compressorium, enabled the instrument to be reversed, so as to give a view of both sides of an object; but there was no provision to secure parallelism of pressure, and it had other important defects. Dr. Carpenter, in the last edition of his work on the Microscope, observed that, in his opinion, nothing could be more suitable to ordinary purposes than an equatic box having a screw collar fitted to it in such a manner that by turning this its cover may be pressed down or raised up as gradually as may be desired, without any rotation of the cover itself or any disturbance of the parallelism of the glasses. This is the character of the new reversible compressorium contrived by Mr. Slack and Mr. Richard Beck, and now manufactured by

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the firm of Smith, Beck, and Beck, but it is more complete than that suggested by Dr. Carpenter. It consists essentially of a very flat screw live box, having a special contrivance to prevent the rotation of the compressing plate, and furnished with springs which elevate the upper plate the instant the tightening of the screw is relaxed. It is so thin that it offers no obstacle to the employment of the achromatic condenser or the parabolic illuminator, and requires no change in the adjustment of the illuminating apparatus when it is reversed.

Another important peculiarity in this compressorium is the way in which the upper and lower glasses are inserted, and the adaptation of the instrument to receive them either moderately thick or extremely thin. The glasses are kept in their places by a slight pressure of four flat-headed screws, two for each. These screws can be instantly turned by a small pair of pliers, or by the finger and thumb, and allow a glass to be replaced or exchanged without a minute's delay. This we regard as a point of great practical value, as much time is lost when the glasses are cemented in. In addition to replacing broken glasses it is frequently desirable to change them, as the very thin glass necessary for high powers will not bear the strain that is inevitable, when many objects that are intended to be examined with lower powers have to be compressed. With the new compressorium thicker plates, top and bottom, can be substituted for thin, or *vice versa*, at a moment's notice, and Messrs. Smith and Beck can, if required, supply two or more of the compressing apparatus to fit the same bed, and thus two or more thicknesses of glass may be always ready for use.

The new compressorium was shown at the October meeting of the Microscopical Society of London, and met with approbation from those who examined it; but we purposely delayed noticing it to see if we could discover any practical defect. We have now employed it on many occasions with frequent change of glasses and with high and low powers, and it appears to us to fulfil more completely than any other compressorium we are acquainted, the varied requirements with which such an instrument is usually employed. In the details of its arrangement there are many little pieces of clever contrivance that would not be intelligible without diagrams, but we have explained the main features of the instrument, which is simple, convenient, and strong.

While upon the subject of compressoriums we may remark that, when the parallelism of the two glasses is required to be extremely perfect, as in the case of minute and very flat objects, either side of which cannot be viewed with deep objectives, care is required in the selection of the glasses, as the ordinary thin glass made for covering microscopic objects is

often very uneven. If no reversal is necessary this does not so much matter, as the bottom glass can then be carefully chosen, and thick enough to allow the upper one to be flattened upon it. When, however, two thin glasses are indispensable, as for the purpose of viewing *both* sides of an object with a $\frac{1}{12}$, $\frac{1}{20}$, or $\frac{1}{35}$, it is necessary to pick out thin glasses that will fit each other with sufficient accuracy. The glasses ordinarily supplied will seldom fail with *moderate*-sized infusoria, but anything flatter than they are needs especial care.

A VISIT TO LAPLAND.*

Few regions of the earth exert a more powerful influence on the imagination than those countries which lie sufficiently near the North Pole to exhibit the remarkable summer phenomenon of an unsetting sun, and which are at the same time so far removed from the regions of perpetual frost as to put forth a vegetation beautiful in its flowers, and magnificent in wide-stretched forests of the sombre fir. It is, indeed, impossible to read of voyages within the picturesque portions of the arctic circle without experiencing to a greater or less extent the feeling so beautifully depicted by Longfellow in the fine story of "The Discoverer of the North Cape," which he borrowed from "King Alfred's Orosius." In that charming legend we learn how Othere, the old sea captain, "had his heart stirred up by the old seafaring men, with their sagas of the seas," until at length he could "neither eat nor sleep for thinking of these seas," and then he sailed northward from his home in Heligoland, and

> "The days grew longer and longer,
> Till they became as one,
> And southward through the haze
> He saw the sullen blaze
> Of the red midnight sun."

Strange seemed the narrative to "Alfred, king of the Saxons," and an "incredulous smile" played over his countenance as Othere continued the story of what he saw and did after passing the North Cape:

> "Four days I steered to the eastward,
> Four days without a night;
> Round in a fiery ring
> Went the great sun, oh king!
> With red and lurid light."

The astronomical puzzle does not bewilder us as it did the

* *A Spring and Summer in Lapland, with Notes on the Fauna of Luleä Lapmark*, by an "Old Bushman," author of "Bush Wanderings in Australia." London: *Groombridge and Sons.*

simple-minded king, but we cannot help the desire to witness a spectacle so startling and sublime, and to make ourselves acquainted with the life of a locality so widely different from our own.

The "Old Bushman" is a pleasant guide to these scenes of wild fascination; a certain ruggedness about him is in harmony with their uncultivated grandeur; their loneliness and remoteness from the tame conditions of civilization rouse his imagination, and he studies their fauna as a naturalist, as well as pursues them for his sport.

He tells us that the tourist who visits Lapland merely to see the country can do so without difficulty. "He will not require to leave England before the end of May; he can perform the whole journey from Hull to Happaranda (the most northerly town in the Bothnian Gulf) *viâ* Gothenburg and Stockholm by steam." There is no certainty that steamers can run the whole way till June, but when Happaranda is reached, "the journey will be performed in boats or on foot, and he will find far less difficulty in reaching the wildest spot in Lapland than he would anticipate." The naturalist, or egg collector cannot, however, manage so easily; he must be at his head-quarters in April, and must therefore steam up in the autumn before the frost sets in, and "brave the rigours and monotony of a Lap winter;" or he may adopt the "Old Bushman's" plan, "and sledge up during the winter, taking care that he is not too late, for the snow melts all at once when the thaw sets in, and just at this time travelling is dangerous, troublesome, and laborious." Our "Old Bushman" left Gardsjö on March 24th, and reached Quickiock on April 16th, having good sledging all the way except for six English miles. Sledging he describes as a very comfortable mode of progression, as good as a first-class railway carriage; but, like other travellers, he indulges in a hearty growl at the peasant carts, which are little shallow boxes stuck upon wheels, and destitute of springs. The driver hurries along over holes and ruts, and the traveller seated on a little plank is obliged "to hold on like grim Death, otherwise he is sure to be shot off his perch, every bone in his skin aching with pain." If not exactly luxurious, the locomotive arrangements in this country have the merit of being cheap, and the people are very honest, and anxious to earn a penny by rendering what aid may be required. The journey to Quickiock occupied about three weeks, during which a thousand miles were traversed, and comfortable quarters found each night. The cost for three persons and a dog was six shillings a day, and one and tenpence posting, making in the whole about £25. The scenery through which he passed is summed up in two words, "snow and pines," and very few birds of any description were seen—

"one Ural owl, one blackcock, and one Siberian jay were all that we shot, and we always had a loaded gun ready in the sledge, but neither heard of nor saw a single wolf."

Having arrived at Quickiock, the "Old Bushman" rarely wandered more than three Swedish miles from it, but in four months he obtained and skinned more than a thousand specimens, besides collecting a great many eggs and butterflies. The first impression of Lapland scenery in the winter he found very striking, but the effect wore off on acquaintance, and a wearisome sense of monotony ensued; "everywhere the view was shut in by barren fells, the tops of most of them covered with perennial snows." An old parish clerk stated that, for forty-two days in the winter, it was so dark you could not see to kill a bird with a rifle at a hundred yards, and these depressing influences act upon the manners of the people; "if you speak to them you get a half-civil answer, but nothing more—their manner is very different from the hearty welcome the stranger receives in old Wermland."

The physical geography of the neighbourhood of Quickiock is excellently sketched in the following passage:—

"The situation of Quickiock is romantic in the extreme, and in the summer it would be hard to find a place in Lapland to beat it for wild, natural scenery. Surrounded on all sides by fells and forests, yet, lying as the village does in a sheltered valley, every kind of ground is met with here, and the naturalist could hardly choose a better station. A large river, the Tara Elf, flows down the fells close by the village; the proximity of the village to the fells themselves renders it peculiarly interesting to the collector; while meadows and swamps choked with grass and every species of aquatic plants, intermixed with numerous small and natural channels, and inland lakes, afford shelter for many species of ducks; but, strange to say, there are fewer waders in this district than in any I know. The Lap forests, in general, present a strange contrast to the deep forests of Wermland and Dalecarlia. The branches of the fir trees all grow in a slanting direction downward, and as they are for the most part dead and jagged, although the trees are small, it is no easy matter to climb them; the meadows and lower grounds are covered with thick plantations of a species of willow, through which, in many places, it is impossible to force one's way, and immediately above them are the forests composed of fir. We see very little pine here, and what few pines we do see are generally blighted and bare. The higher we ascend the fell sides the smaller become the forests, till at length we miss the fir altogether and reach the birch district. On leaving this we come to the fell birch, which, exposed as the trees are to the cutting wind

in all directions, assumes every fantastic shape. At first, the fell-birch grows to a height of about four feet, but when we come higher up the fells it dwindles to a mere bush, and at length becomes nothing more than a creeper, matted and tangled on the ground; but the dwarf willow (*Salix herbacea*), the smallest shrub in the world, grows on some of the fells as high as the dwarf birch. Above this, the fells assume their true character, and are covered with lichens or mosses, and in many places with perennial snows."

The lines of vegetation are clearly defined as the traveller looks from a fell top down its sloping sides, and the fells are composed of huge masses of iron-stone and shingle, of all shapes and sizes, towering above one another, and capped with snow. During the short, but active summer, "no one, who has not seen it, can picture to himself the beauty of the valleys that lie between and at the foot of the fells themselves. Nowhere have I seen so rich a vegetation, or such a profusion of wild flowers, as bloom in this so-called wilderness; and nowhere do the wild flowers appear so beautiful as when we see them in a spot where we least expect to meet with them." . . . To stand in one of these fell valleys on a carpet of grass and moss, as soft as the richest mat Turkey can yield, variegated with wild flowers of every hue, from one to the other of which, rare and beautiful butterflies are continually flitting—to see the rugged fells themselves, frowning down in severe majesty upon one, excites a feeling of awe, perhaps, rather than admiration; and though we know that not a human being is within miles of us, we cannot call it solitude :—

"Tis but to hold
Converse with Nature's charms and view her stores unrolled."

During two summer months the nights were as light as days, and shooting could be done as well at midnight as at noon. The "Old Bushman" gives some magnificent descriptions of scenes at night, with the sun pursuing his course above the horizon; but for them, and for many details of natural history we must refer to his own pages.

The Swedish bear he found "a very well-behaved animal" if unmolested, and wolves are by no means plentiful. The quadrupeds and the fish occupied a fair share of the "Old Bushman's" attention, but birds and eggs were the principal objects of his pursuit. About March 1st he tells us the ice and snow began to melt; on the 10th of April the snow bunting appeared; on the 25th, wild geese, swans, and larks, arrived. The papillio (vanessa?) urticæ was seen, and patches of bare ground appeared. On the 1st of May came the white wagtail; on the 24th the marsh marigold was in flower; on the 28th the birch in leaf. June is a warm month, but night

frosts appear in August, and by the 20th of September the birch sheds its leaves, and by Michaelmas the first snow-storm usually arrives.

While in Quickiock, the "Old Bushman" was so fortunate as to witness a migration of lemmings, and, as might be expected, he strips off a great many improbable particulars which romancing travellers have been in the habit of adding by way of illustration to the actual proceedings of these elegant little animals. They usually journeyed by night, did very little harm, and were not in the habit of climbing walls or entering buildings of any kind.

As a book for general reading, the *Spring and Summer in Lapland* will be found one of the pleasantest of the season. Its author has a strong, native faculty for seeing and describing, and is so happily ignorant of the mere craft of bookmaking, that his pages are as far removed from commonplace as the genuine products of the Lapland fells. It is, however, as an ornithologist that he will be most appreciated by scientific men, and his chapters on these subjects are filled with original observations that evince an earnest desire for truth as well as unusual aptitude for this species of research. We shall give only one extract from this part of his work, but those who seek its pages for themselves will find abundance of material that is important and new. Our closing citation relates to the disputed question of the moulting of the ptarmigan. It runs as follows:—

"The question now arises, how many times can the ptarmigan be said really to moult in the course of a year? I don't mean change colour, for a change seems to be going on all through the summer, but *actually to moult*. . . It is quite clear to me that the change from the pure white winter dress to the mottled plumage of spring is an *actual moult*, and no change in the colouring of the feathers; for in all the specimens I obtained from the middle of April to the end of May, the variegated mottled feathers were to be seen, of all sizes, shooting out from the skin, with blood shafts among and under the white feathers in all parts of the body, some very small and quite hidden by the white plumage, others full grown and occupying patches on the white ground. In not one of these specimens killed at this time could I observe the slightest indication of a white feather gradually changing colour." The autumn dress he considers also the result of a perfect moult, as he observed a growth of new feathers late in July and early in August, and he likewise considers the change from the blue dress of autumn to the white one of winter another moult, this making three moults between April and November. This opinion he gives advisedly, but states that he shall be willing to change it, if evidence appears that he is wrong.

NOTES ON THE VIBRIO FAMILY.

BY HENRY J. SLACK, F.G.S.,

Member of the Microscopic Society of London.

In my remarks on the vinegar plant in the last number of the Intellectual Observer, I expressed doubts, which I believe most microscopists feel, with respect to the naming and identifying of the various objects that may be roughly described as belonging to the so-called Vibrio family; and while acceding generally to the views of M. Pasteur, that such bodies are agents of putrefaction and fermentation, I observed that if his statements should be confirmed, and it should be found that one set of these bodies live in oxygen, and perform one set of functions, while another set dies in it and perform another set of functions, we might distinguish them by habit, if not by appearance.

So able an observer as M. Pasteur is scarcely likely to be in error, when he tells us that he has discovered organisms of this kind that live and multiply without oxygen, and others that live and multiply in connection with it; but when he states that the objects arranged by Ehrenberg as six species* of vibrions, are all ferments of putrefaction, and perish in contact with pure oxygen, we may, without in the least impugning the value of his researches, doubt if he could tell by microscopic examination whether certain vibrio bodies belonged to the race of dwellers in oxygen, or to those whom it kills. These doubts are strengthened by a paper recently read before the French Academy by M. J. Lémaire, who disputes many of M. Pasteur's propositions, and recounts the following experiments:—He saturated many infusions that were rich in vibrions with carbonic acid, and then sealed up the tubes containing them. At the end of forty-eight hours most of the "animals," as he carelessly calls them, were motionless, and on the sixth day all were dead. He adds, "M. Pasteur states that the bacteriums absorb oxygen, and that vibrions live in carbonic acid. I do not accept this theory, relying on the experiments cited, and considering the *bacterium termo* and the *vibrio lineola* to be the same animal in a different degree of development." "How," he asks, "can we believe that the animal that is a bacterium in the morning, and a vibrion some hours later, can live under conditions so different?"

M. Lémaire exhibited to the Academy several closed vessels containing a little air and putrescible matters, and from the

* In the March number, p. 239, for "Ehrenberg constituted *six genera* of vibrions," read *six species*.

state of their contents after they had been kept for some time in a warm place, he concluded that "putrefaction commences in a closed vessel by help of the oxygen it contains; this gas permits bacterium, vibrio, and spirillum to grow and live for a certain time, but when the oxygen is consumed they die, and putrefaction is arrested." On reference to the September number (1863) of the INTELLECTUAL OBSERVER, p. 101, it will be seen that M. Pasteur stated that when putrefaction occurred in closed vessels *monas crepusculum* and *bacterium termo* first appeared and exhausted the oxygen, and then, if the liquid contained no fecund germ of the vibrion ferments, it remained without change. This he said was rare, but he had met with several examples. Most frequently, however, in his experiments the vibrions appeared and the putrefaction proceeded.

M. Lémaire disputes M. Pasteur's assertion that there exists special ferments that assist each kind of fermentation; and he states that in his own experiments *bacterium, vibrio, spirillum,* and *monas* transformed a saccharine solution into alcohol, and then into vinegar. In the fermentation of wheat flour he observed, in the course of fifteen days, *bacterium, vibrio, spirillum, amœba, monas,* and *paramecium,* after which came what he calls *microphytes*—a term which most observers would consider ought to include the so-called vibrion family, or most of its members. He distinguishes two epochs in putrid fermentations. During the fœtid stage he observed thirty species of microzoaries. The clearing stage, he states, is announced, when the operation is carried on in the light, by the appearance of the green matter, after which the infusoria that existed in the fœtid stage gradually disappear, and are replaced by *euglena, vorticella,* and *protococcus.* In this case he considers the putrefaction is chiefly due to the oxygen evolved by the green matter.

In the case of neutral liquids, animal or vegetable, he affirms that microzoaries begin the decomposition, and when the liquids become acid, microphytes appear, and the animalcules grow motionless. In the melon, in which saccharine and nitrogenous matter is associated with a small portion of acid, animalcules and moulds appear simultaneously, while in substances decidedly acid he believes microphytes begin the decomposition, and "when the acids are transformed, so as no longer to hurt the microzoaries, these little animals appear, and with them other chemical phenomena." The appearance of species belonging to the animal or vegetable kingdom he considers subordinated to the chemical composition of the substance.

The influence of acids he finds so great in determining the order of the appearance of ferments, that he can by feebly

acidulating neutral substances with acetic, lactic, oxalic, or tartaric acid cause microphytes to take the place of microzoaries, and by the converse process of diluting the acids with water, substitute the microzoaries for the microphytes.

The bearing of the preceding observations upon sundry questions propounded in my paper on the vinegar plant will be obvious, but it is a pity M. Lémaire has introduced so much confusion by a very loose employment of the terms microzoaries and microphytes. Many of his "animals" possess no animal characteristics whatever, and many of his microphytes may be merely some of the so-called "animals" in another stage of development. In the vinegar plant the bacterium bodies which, according to his nomenclature, would be "animals," live and thrive in any acid fluid.

In further discordance with M. Pasteur, Mr. Lémaire believes that, in the process of vinegar manufacture, a direct oxydation occurs as well as that exerted by the ferment, and that the *mycoderma vini* is able to transform alcohol into acetic acid. He remarks that, "in watching the fermentation from its commencement in the must of wine, in vinegar, and in the decomposition of vinegar he has proved the presence of the same mycoderms operating in all these transformations. Upon this, it may be remarked, that the oxydation by which alcohol is transformed into acetic acid, and the further oxydation by which that acid may be again transformed into water and carbonic acid, are processes of the same kind, and naturally produced by the same ferment, and we should get no vinegar at all except for the fact that, while the vinegar plant has plenty of sugar to act upon, it does not destroy the vinegar it has already made. If, however, the yeast plant and the vinegar plant be specifically the same, the condition of the plant must differ, or we could not depend on obtaining alcohol by putting yeast-cells into a saccharine solution, and be equally sure of getting vinegar if the vinegar plant was immersed in another solution of precisely the same kind.

M. Lémaire considers that his remarks throw light upon certain diseases in which microphytes appear on the skin—a state of things he ascribes to the acidity of the secretions; but he does not tell us whether he has ascertained that the secretions are more acid in such disorders than in others in which no microphytes are seen.

It is often a subject of regret in reading French scientific works that our distinguished neighbours do not pay enough attention to what other folks do. M.M. Pasteur and Lémaire would both have arrived at more definite results if they had taken into their consideration the researches of Cohn, Burnett, Arlidge, and others, into the history of organisms, to which

they attribute animal and vegetable characteristics upon insufficient grounds, and the connection of which with other forms of life they do not seem to appreciate.

COMETS.

AN ACCOUNT OF ALL THE COMETS WHOSE ORBITS HAVE NOT BEEN CALCULATED.

BY G. F. CHAMBERS.

(*Continued from page* 222, *vol.* iv.)

499. A comet appeared previous to the second invasion of Illyria by the Bulgarians.—(Zonaras, *Annal.* ii. 56. Ed. Paris. 1686.)

501. On February 13 a great comet appeared in the horizon. On March 2nd it was still visible.—(Ma-tuoan-lin.)

504. A great and brilliant star with a long ray appeared about the time of the death of Ambrosius Aurelius.—(Galfredus, *Britann.* viii. 4.)

507. On August 15th a comet was seen in the N.E.—(Gaubil.)

519. A "fearful star," with a tail turned towards the W., was seen this year, possibly in the winter.—(Theophanes, p. 143; Malala, *Hist. Chron.* xvii.)

520. On October 7th a comet was seen in the E., bright, like fire. On November 30th it was seen in the morning.—(Gaubil.)

524. A star was seen for twenty-six days and nights "above the gate of the palace."—(Cedrenus, *Compend. Hist.* p. 365. Paris. 1647.)

530 or 531. A great comet was observed in Europe and China, but accounts differ as to the year, though probably it was 531. "It was a very large and very fearful comet," and was seen in the W. for three weeks. Its rays extended to the zenith.—(Theophanes, p. 154; Malala, xviii.) It was observed [? passed] in October from α Boötis to λ and μ Ursæ Majoris.—(De Mailla, v. 299.) Hind thinks that this was *Halley's Comet*. If it arrived in perihelion at the beginning of November, it would have occupied the positions given by the historians, and anyhow it must have been near perihelion at this time. It is not impossible that there was a comet in each of the above years, a theory which might perhaps remove some of the discrepancies which exist, supposing there only to have been one comet.

534. A comet appeared in Leo and Virgo; passing ν

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and ξ Ursæ Majoris, it moved to the square of Pegasus.—(Gaubil.)

556. In November a comet, in the form of a lance, extended from E. to W., or from N. to W.—(Malala, xviii.) Some writers date this for 555.

560. On October 9 a comet with a tail 4° long, pointing towards the S.W., was seen.—(Gaubil.)

563. A comet, like unto a sword, was seen for a whole *year* (? month).—(Greg. of Tours, *Hist. France*, iv.)

565 [i.] In April—May a comet appeared.—(Ma-tuoan-lin.)

568 [i.] On July 20 a very brilliant comet was seen in Gemini. It moved towards the E. and stopped eight "feet" [or degrees?] north of θ Cancri on August 18, and then disappeared.—(Ma-tuoan-lin.)

575. On April 27 a comet was seen near Arcturus (α Boötis).

581. On January 20, a comet appeared in the S.W.—(Ma-tuoan-lin.)

582. "In the month of January many prodigies were seen. A comet appeared situate, as it were, in a sort of opening; it shone in the midst of the darkness, sparkled and spread out its tail. From the comet a ray of surprising magnitude emanated, and which appeared like the smoke of a conflagration as viewed at a distance. The comet was visible in the W. from the first hour of the night."—(Idatius, *Episcop. Chron.* vi. 14.)

584. A comet, like a column of fire suspended in the air, was observed, and a great star appeared above it.—(*Chron. Turonense.*)

588. On November 22 a comet appeared near β Capricorni.—(Ma-tuoan-lin.)

591. A comet appeared for one month.—(Bonfin, *Rer. Hungar*, I., viii.)

595. On January 9 a comet was visible near β Aquarii. It moved by α Aquarii, ϵ Pegasi, towards α Andromedæ and α Arietis.—(Ma-tuoan-lin; Simocat. *Hist.* vii.)

602. A comet like unto a sword was seen in this year.—(Theophan. p. 240.)

About 605 [i.] In April or May a comet was seen.—(Paul Diacon, *De Gest. Longobard*, iv. 33.)

About 605 [ii.] In November or December a comet was seen.—(Paul Diacon, iv. 34.)

607 [i.] On March 13 a comet was seen in the sidereal division commencing at μ Geminorum, and near ν and ϕ Ursæ Majoris; it passed by κ, τ, θ, etc., Persei, Auriga, α and β Geminorum, the vicinity of β Leonis, and α Herculis, and stopped after fourteen weeks.—(Ma-tuoan-lin.) Probably for Ti-tso (α Herculis), we should read, as Hind suggests, Ou-ti-

tso (β Leonis), and if we suppose the "ι and ϕ Ursæ Majoris" to allude to the place to which the tail extended, this otherwise inconceivable route will appear more reasonable.

On April 4 a great star appeared in the W. It traversed the girdle of Andromeda, and passing by α Arietis came to Virgo. —(Gaubil.) The Chinese account refers this to another comet, but Hind thinks "it is more than probable that in the description of these so-called *first* and *second* comets of this year, there is some confusion as regards the order in which a *single* comet may have passed through these sidereal divisions and constellations; or observations of the direction of the tail may be mixed up (as occasionally happens) with the positions of the head."

607 [ii.] On October 21st a comet appeared in "the southern region," was seen in Virgo, and passing in the vicinity of β Leonis came to α Herculis; it approached near many constellations, but did not reach the cross of Orion or Gemini.—(Ma-tuoan-lin, who declares this comet to be identical with that of the 4th of April.) For α Herculis, Pingré reads β Leonis, as above, and thinks the European comet or comets of 605 the same as the Chinese comet or comets of 607.

608. A comet emerged this year from α and β Aurigæ, and passing υ, ϕ, etc., Ursæ Majoris, came to β and δ Scorpii.—(Ma-tuoan-lin.) This is precisely the path which *Halley's Comet* follows when its P. P. occurs in October, and as that comet was due about this year, Hind thinks this was it.

614. A comet appeared for one month during the occupation of Jerusalem by Cosroës, King of Persia.—(Lubienitzki, etc.) Date very uncertain.

615. In July a comet was seen to the S.E. of υ and ϕ Ursæ Majoris. It was from 50° to 60° long, and its extremity had an undulating motion. It moved to the N.W. for some days, and when it had nearly reached the circle of perpetual apparition it retrograded and then disappeared.—(Ma-tuoan-lin.)

617 [i.] In July a comet with a tail 3° or 4° long was seen near β Leonis; after some days it disappeared.—(Ma-tuoan-lin.)

617 [ii.] In October a comet appeared near α and β Pegasi. —(Ma-tuoan-lin.) It was seen close to the tail of the Lion, and disappeared after some days.—(Gaubil.)

626. In March an extremely brilliant star was seen in the W. after sunset.—(*Chron. Pasch.*) On March 26 it was situated between the sidereal divisions of the Pleiades and Musca. On March 30 it was near υ Persei.—(Gaubil.)

632. In May or June, or a little later, a sign appeared for four weeks in the S. It was called a "beam," and extended from S. to N.—(Cedrenus, p. 425.)

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633. A comet in the form of a sword was seen.—(Weber, *Discursus Curiosi*, etc.)

634. On September 22 a comet appeared near β Aquarii and α Equulei, and α Aquarii and ϵ, θ Pegasi; it passed through Aquarius, and disappeared on October 3.—(Gaubil.)

639. On April 30 a comet was seen between the Hyades and Pleiades.—(Ma-tuoan-lin.)

641. On July 22 a comet was seen in the region near β Leonis; it approached Coma Berenicis, and disappeared on August 26.—(Ma-tuoan-lin.) De Mailla dates this comet a month earlier, and Gaubil says it was in the β Leonis region on August 1.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

GEOLOGICAL SOCIETY.—*Nov.* 4.

On some Ichthyolites from New South Wales.—Sir P. de M. Grey Egerton exhibited some specimens and photographs of Ichthyolites from New South Wales; these enabled him to distinguish four genera, two of which are new, and allied to *Acrolepis* and *Platysomus* respectively; the known genera being *Urosthenus*, Dana, and *Palæoniscus*, Agass. Sir Philip was of opinion that these genera were sufficient to stamp the deposit in which they occur—namely, the Coal formation of New South Wales—as belonging to the Palæozoic period, if they may be regarded as representative genera living at the same period as, but geographically distant from, their nearest allies; but, as regards the actual age of the formation, the allied genera are more abundantly represented in the Magnesian Limestone and the Kupferschiefer than in the Coal measures.

On the Geology of the Nile Valley north of the Second Cataract, in Nubia.—Dr. A. Leith Adams' paper on the Geology of the Nile Valley described the physical features of the district, beginning at Selsileh and proceeding southwards, and then the lithological and stratigraphical characters of the Nile sandstone, as well as its mode of junction with the granite, noticing also the evidences of the Nile having shifted its bed, and of other physical changes occurring in Nubia. Near the Second Cataract were abundant proofs of the river having formerly flowed at higher levels, the author having found river shells, such as *Cyrena fluminalis*, *Paludina bulimoides*, *Iridina Nilotica*, and *Œtheria semi-lunata* (the Nile Oyster), as also *Bulimus pullus* and a *Unio* like *U. pictorum*, in beds of alluvium on elevated plateaus at various heights, ranging up to 130 feet, above the highest inundations of the present day.

Dr. Adams concluded from these facts that the Nile was formerly a more rapid river than it is now, and that the force and wearing power of the stream has been steadily declining since the upheaval of the valley ceased.

Dr. Falconer also described two molars in a fragment of the left maxillary of a very large Hippopotamus; the specimen was dug up near the old Temple of Kalàbshe, in Nubia; and belonged to the same species as the existing Hippopotamus of that country.

ROYAL GEOGRAPHICAL SOCIETY.—*Nov.* 9.

Discovery of Snowy Mountain Peaks in Tropical Africa, by Baron von Decken.—A paper was read from the Baron von Decken, in which he mentioned that, on leaving Mombas, he proceeded southward along the coast to Wanga, and thence struck westward up the river of that name. On reaching the Ugono range, 5000 feet high, he found himself among a well-formed race, sufficiently civilized to smelt iron, very rudely, certainly, but with sufficient success to enable them to make no contemptible weapons. He experienced much opposition from the natives, who had got a notion that the mere presence of a European would prove fatal to their cattle. On leaving the Wa-Ugono, or people of Ugono, he coasted Lake Jipé on the west side, and, on reaching the northern end, discovered that the river Daffeta, after entering it from the elevated tract beyond, left it within a mile or two of its entrance. The next point was the Aruscha range, about 4000 feet high, beyond which, at a considerable distance, was another lofty range, probably the eastern watershed of Lake Victoria Nyanza. From this point there was a fine view of the two snowy peaks of Kilima-ndjaro. On ascending the mountain, accompanied by Dr. Kärsten, an accomplished astronomical observer, he encamped the first night at 6000 feet, the next at 11,000, in heavy rain, and saw snow at an elevation of about 13,000 feet. This disappeared by about 9 A.M., but left a clearly defined limit of what seemed to be perpetual snow at about 17,000 feet, the triangulations having previously given the main peak an elevation of 20,065 feet, and the other upwards of 17,000. Still advancing upwards, he attained a height of 13,900 feet, when his companions having given way, owing to the increasing rarefaction of the atmosphere, he was compelled to retrace his steps. He then returned through the Djagga country to the coast. One of the most interesting features of Baron von Decken's paper was a detailed account of a fly, called by the natives "Donderobo," whose bite, as deadly as that of the better known Tsetse, described by Livingstone, was fatal to asses and dogs only; involving serious inconvenience and even danger to the expedition, by the destruction of the draught asses of the caravan. The effect of the poison seemed to be to produce tubercular deposit, following immediately upon acute inflammation.

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BRITISH METEOROLOGICAL SOCIETY.—*Nov.* 19.

Meteorological Disturbances during the Storm of Oct. 30, 1863.—At the meeting of the British Meteorological Society, Mr. Glaisher exhibited an elaborate diagram showing the unusual disturbances that occurred during the great storm of October 30, 1863. In the neighbourhood of Greenwich the greatest intensity of the storm was at half-past three in the afternoon, the period when the engine-house at New Cross Railway-station was blown down. At the Observatory at Greenwich it was noticed that the barometer suddenly fell to 28·7, whilst the thermometer as instantaneously rose to 53° Fahrenheit. At the same time the wind, which had suddenly veered round from south to nearly due north, instantly increased in pressure from a very moderate amount to 29½ pounds on every square foot, being a greater degree of pressure than has occurred in this country for thirty years. In describing these phenomena, Mr. Glaisher asserted very strongly on the extreme importance of self-registering instruments, as these registrations could not have been obtained without their aid.

Mr. Glaisher also made some observations on the shooting stars of August 10, and exhibited a model illustrating the mode in which their height above the earth's surface was computed. This is done by observing their angular altitude at different situations simultaneously, and then calculating their height trigonometrically. The large meteor of August 10 last was, when first observed, 130 miles from the earth's surface; it rapidly approached within a distance of fifty miles, and then vanished. The light emitted by these shooting stars was attributed to the friction and compression of the air by the rapid passage of the body through it, the velocity having been computed as amounting to 60 miles per second.

CHEMICAL SOCIETY.—*Nov.* 19.

Vanadium in English Pig Iron.—Mr. Riley read a paper on the detection of the rare metal, vanadium, in English pig iron. Vanadium was originally discovered in the iron produced at Jaberg, in Sweden, and subsequently in the form of vanadiate of lead at Zimapan, Mexico. It has more recently been detected in a variety of iron ochre, and in the French mineral, Bauxite, now so largely employed as the source of aluminium.

Vanadium has an important practical application in the preparation of an improved form of writing ink. Ink of the very finest and most intense black may be prepared by adding a very minute portion of vanadic acid or vanadiate of ammonia to a solution of nut-galls. This ink is indelible by the ordinary agents that destroy the colour of the iron ink in common use, and it resists a very high temperature. Hence it has been suggested as peculiarly adapted for special purposes, and therefore a new source of vanadium is consequently a matter of considerable practical as well as scientific importance.

A paper was read by Dr. Frankland and Mr. Baldwin Duppa on the formation of compounds of the organic radicles, Ethyle, Methyle, and Amyle with the metal Mercury.

Methide of mercury is formed when an amalgam of sodium and iodide of methyle are allowed to re-act upon each other, the chemical action being established by the addition of a small quantity of acetic ether, which appears to remain unchanged during the process. This compound is a direct combination of the metal Mercury with the organic radicle, Methyle C_2 H_3. In appearance it resembles water, but is remarkable for its great specific gravity, being rather more than three times the weight of that liquid; consequently flint glass containing a large proportion of lead floats on its surface.

NOTES AND MEMORANDA.

Brain of a Bushwoman and Brains of Idiots.—Mr. John Marshall, F.R.S., Surgeon to University College Hospital, has a paper in the *Proceedings of the Royal Society* on the above subjects. The Bushwoman was aged, and about five feet high—unusual for her race. Her cranium is a long narrow ovoid, less dolichocephalic than that of the negro. The frontal sinuses absent, and cranial walls very thick. The cranial capacity is 60·64 cubic inches, equal to 35 oz. av. of water, which, for her height, is decidedly, but not very small. The probable weight of the recent brain is 31·5 oz., or 8·5 oz. less than the average of Europeans of same age. The ratio of cerebrum to cerebellum is usual 7·7 to 1; and that of cerebrum to body probably as 1 to 52; of cerebellum to body as 1 to 418, instead of the usual ratios of 1 to 41, and 1 to 328. Cerebrum defective in width and especially in height, fissures more complex than in Hottentot Venus, but much less so than in the European; they are rather more complex on left than right side of brain, and widely separated from those of the ape's brain. All the convolutions proper to man were present, but much more simple and less marked with secondary sulci. Mr. Marshal remarks that there is a greater difference between the Bushwoman's cerebrum and the highest ape's cerebrum, than between it and the European cerebrum; but a less specific difference between it and the European than between the chimpanzee and the ourang outang. There is, however, less difference between the Bushwoman and the highest ape than between the latter and the lowest quadrumanous animal.

Of the idiots' brains, one was that of a woman aged forty-two, the other of a boy of twelve. The former could walk, though badly, nurse a doll, and say a few words; the latter could neither walk, handle anything, nor articulate a word; the idiot woman's cerebrum weighed 7·6 oz., the cerebellum 1·95 oz.; the pons with medulla oblongata 42 oz. The boy's cerebrum 5·85 oz., cerebellum 2·25 oz., pons, etc., 4 oz. "These are the two smallest brains, the weights of which have been recorded. At first sight the woman's brain resembled that of a chimpanzee: but close comparison shows great differences. The cerebellum especially is of very great size, forming about one-fourth of the entire mass, and instead of being covered by the cerebrum has about ·35 inch of it exposed posteriorly." Mr. Marshal says that "these idiot cerebra have fewer parts and less complex than those of normal brains, and he considers their peculiarities due to arrest of development at some period of fœtal existence. The convolutions in the idiot's brains are more simple than those of the higher apes, and approach, in this respect, those of the lower quadrumana. But the points of difference between the idiot's brains and those of the quadrumana are very decided. They are human cerebra, although so imperfectly developed."

Subdivided Lightning.—At a recent meeting of the *Société Hélvétique des Sciences Naturelles*, Professor Dufour mentioned the curious fact, that in last

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June the lightning fell on a vineyard at Clarens, and struck 150 trees, having split into so many branches.

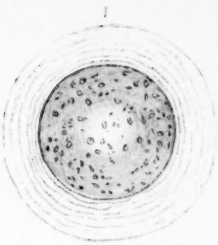
Hermaphrodite Bees.—At the same meeting, Professor von Siebold stated that M. Engster, of Constance, had a hive of bees, now four years old, which constantly produced a number of hermaphrodites, which the working bees turned out by hundreds soon after they were born. These hermaphrodites did not resemble each other; sometimes one side was male and the other female; sometimes the head, antennæ, eyes, etc., belonged to one sex, while the posterior portions belonged to another. At other times, the exterior characteristics alternated in rings, and even in half rings. The internal organs exhibited equal diversity. In some cases the hermaphrodites had the sting of the working bees, in others the male organ of the drones, and there were instances of both united. Moreover, the external and internal characteristics frequently failed to correspond, one belonging to one sex and the other to another. Some individuals had the internal arrangement of males on one side on the right and of females on the left, but their exterior was arranged in an opposite manner. One characteristic was constant, that the ovaries were formed like those of the workers, and contained no eggs; while the testicles were completely developed, and exhibited zoosperms. The professor observed that the sex of bees depended on fecundation, eggs into which zoosperms entered becoming females (queens or workers), while unfecundated eggs become males. The eggs from which the hermaphrodites came were laid in workers' cells, and consequently were intended to produce working bees; but they were incompletely fecundated, and thus the development of female organs did not pass beyond a rudimentary state.

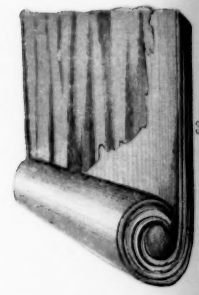
Change of Habit in Species.—Professor Strobel observed, at the meeting just named, that he had found in the Po a macrurous crustacean, which he considered to be the *Palæno lucustris* of Lake Garda, affording an illustration of a marine species gradually habituated to fresh water.

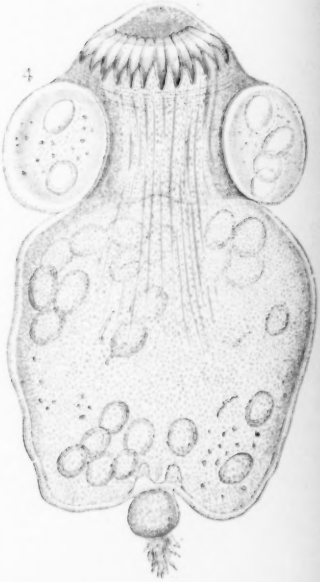
Dr. Wallich on the Amœbæ.—Continuing his important researches, Dr. Wallich arrives at the conclusion that the circulation in the amœbæ is a mechanical effect consequent on the contractility of the sarcode, and not a vital act, "the particles simply flow along with the advancing rush of protoplasm. There is no return stream, but the semblance of one is engendered by one layer of particles remaining at rest while another is moving past them." Dr. Wallich instances additional reasons for considering the various forms of amœbæ as one species, and for confirming the opinion he formerly expressed, that the appearance of a membranous ectosarc betokens encystation. This change he thinks occurs when the reciprocal interchange between endosarc and ectosarc ceases from diminished vitality. (See Intellectual Observer, xviii., p. 434.) Further information will be found in the *Annals of Natural History*, vol. xii. No. 71.

Comet V., 1863.—M. Tempel discovered this body at Marseilles on the 4th of November, AR = 173° 15′ SD = 10°. It had the brightness of a 4 magnitude star, and a tail more than one degree long. On the 1st of November, M. Tempel found its daily movement to be $+1\frac{1}{2}^{\circ} + 1\frac{1}{2}^{\circ}$, the same in right ascension as in declination. On the 9th, Dr. Bruhns saw it at Leipzig, and reported to *Astron. Nachricten*, "the nucleus is very bright, and was readily visible, even in the neighbourhood of Venus, with the naked eye. Of the tail we saw little; in the comet finder it appeared to be one degree long."

Vipers of France.—M. Soubeyran describes three species of these venomous reptiles as belonging to France and Central Europe, *V. aspis*, *pelias*, and *ammodytes*. The last has a triangular head, separated from the body by a narrow neck and a prolonged muzzle. He remarks that the characters of the two other vipers vary very much with the locality, the nature of the soil, and even with the season, thus giving rise to numerous sub-species. *Cosmos* affirms that viper-hunters may find abundance in the forest of Fontainbleau, between "les Monts des Fays and la Mare aux Evées," a mile or two from the station of Bois-le-Roi.







Tænia echinococcus.